Summary Report

COLUMBIA RIVER BASIN AREA AGRICULTURAL PROGRAM

U.S. DEPARTMENT OF AGRICULTURE

AGR-SCS-PORTLAND ORE SEPT 1953

SUMMARY REPORT

COLUMBIA RIVER BASIN AREA

AGRICULTURAL PROGRAM

UNITED STATES DEPARTMENT OF AGRICULTURE

MAY 1954

FOREWORD

The Columbia River Basin area occupies about 176 million acres of land and water in the northwestern part of the United States. It includes all of the State of Washington, most of Oregon and Idaho, western Montana and small parts of Wyoming, Utah, Nevada and California. In northern Montana a small part of St. Mary's drainage tributary to Hudson Bay is also included. In western Oregon and Washington all streams flowing into the Pacific Ocean and Puget Sound are included.

The Columbia River Basin area has great potentials. It is the gateway to Alaska and the Orient. Its streams contain the greatest unharnessed hydro-power potential in the United States; the largest remaining commercial stands of virgin timber in the nation are within its boundaries; an estimated additional 4 million acres has been classed as irrigable; the scenic beauty, wildlife resources and natural recreational advantages are outstanding; and the rate of population growth in the area in recent years has been among the highest in the nation.

The Columbia River Basin area is also an area of great contrasts. Elevations range from sea level to over 14,000 feet; annual precipitation varies from less than 6 inches to over 200 inches; and population density on a county basis is as low as one person per square mile in some counties to a high of 343 persons per square mile in the more populated counties. The wide variation in climate and soils permits a great diversity of crops to be grown; and the amount of cropland varies from less than 3 percent of the area in the range country to over 50 percent of that in the Palouse.

Wise use of the resources requires that proper balance be maintained in their development and utilization. Plans have been developed and are

being implemented for the Columbia River Basin area's water resources for irrigation purposes, for flood control of the main streams, and for power development. To bring the area's agriculture resource development and conservation into proper balance and to coordinate such development with other planned resource utilization, the Department of Agriculture has prepared this Summary Report, Columbia River Basin Area Agricultural Program.

The agricultural program report consists of three phases. It contains an inventory of the agricultural resources--forests, ranges, croplands, water and allied resources; it contains a review of the problems associated with the development, conservation and utilization of these resources; and it contains recommendations for a program of measures and practices designed to permit the maximum economic development consistent with proper conservation and utilization of the area's agricultural and allied resources.

The Columbia River Basin area has a fortunate combination of factors and circumstances which presage a great potential development. It has a young economy, having been settled by white man only slightly over 100 years ago. Its natural resources, though having been grossly exploited, still are major factors in future development.

The area is vast in size. It includes 84.5 million acres of forests, 64.3 million acres of non-forested range, and 18.5 million acres of cropland. Other major resources are water, minerals, fisheries and wildlife.

Forest land, range land and cropland, while denoting major use, are subject to multiple use, and each use is interdependent upon other uses. For example, forest land, while primarily devoted to timber production, is also of major importance for water source areas, for

grazing, habitat of wildlife and recreation. Rangeland and cropland are likewise subject to multiple uses.

The Columbia River Basin area contains a saw timber volume of about 730 billion board feet of timber. Annual saw timber production is about 15 billion board feet and other timber uses amount to an additional 174 million cubic feet. In 1949 the timber products had a primary value of about 829 million dollars.

In 1950 there were about 2.4 million beef cattle, 2.8 million sheep and lambs, over a million deer and 180,000 elk, plus lesser numbers of other big game which were dependent upon the basin's watershed lands for grazing. The value of the livestock sold alive in 1949 was about 215 million dollars.

The cropland, while occupying but 10.6 percent of the basin area, is of major importance to the economy of the area. A wide diversity of crops are grown, both with and without irrigation. Crop yields are consistently the highest, or among the highest, in the nation. About 4.1 million acres or 15.4 percent of the nation's irrigated land is in the Columbia River Basin area. In 1949 the value of all crops and dairy products sold amounted to 639 million dollars.

The very nature of the area's resources and of their interdependence creates complex problems associated with their use and development. The problems are accentuated by pressure of a rapidly increasing population. Among the major problems are those associated with the conservation, development, and use of the land with the crops grown on it, and with the upstream management of the water sources so that maximum use is gained from these extremely important resources.

The agricultural program outlined herein for the cropland, rangeland and forest land consists of agronomic, management and structural measures

or practices. Facilitating measures, such as research, education, surveys and credit are also included. The program has been designed and correlated to achieve the following results: conserve and improve the lands and increase their productivity; protect, utilize and increase the forest and range resources; protect, enhance, develop and utilize the water resources; improve the use of land and water through improved farm irrigation and drainage; reduce upstream floodwater and sediment damages; and protect and improve recreational facilities and encourage development and maintenance of appropriate wildlife population. This program will complement the major structural programs for the development and utilization of the area's water resources now planned and under way.

The benefits gained from adoption of the agricultural program will be manifold. It will complement the major structural programs for development and use of the area's water resources which are planned and under way. The basic land and upstream water resources will be conserved, developed and managed so that the agrarian and industrial economy of the Columbia River Basin area will be maintained and greatly strengthened; and the social and socio-economic status of the urban and rural communities will be maintained or improved.

ACKNOWLEDGMENTS

The following agencies of the Department of Agriculture, as it was then organized, participated in the preparation of this program.

Agricultural Research Administration

Bureau of Agricultural Economics

Extension Service

Farm Credit Administration

Farmers Home Administration

Forest Service

Production and Marketing Administration

Rural Electrification Administration

Soil Conservation Service

Upon request by the Secretary of Agriculture, the University of Idaho, Montana State College, Oregon State College and the State College of Washington, through their Resource Development Council of the Pacific Northwest, Land Grant Institutions assigned a representative to assist in development of the program. A Field Committee was formed consisting of a representative of each of the above agencies and of the Council.

This committee was under the leadership of the Field Representative, Office of the Secretary. The Field Committee had the primary responsibility of developing the Agricultural Program.

Subcommittees and task forces consisting of specialists from the above Federal agencies, Land Grant Institutions and other state agencies concerned with conservation, development and use of land, developed various phases of the program.

In collecting basic data, in analyzing program needs, and in developing the recommended program, the United States Department of Agriculture received much information and assistance from officials of various agencies of The Department of the Army, The Department of the Interior, The Department of Commerce, Federal Security Agency, and state and local agencies concerned with agriculture and forestry.

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COLUMBIA RIVER BASIN AREA

1951

25 0 25 50 75 100

SCALE IN MILES

U.S. DEPARTMENT OF AGRICULTURE

DESCRIPTION OF THE COLUMBIA RIVER BASIN AREA

Location and Size

The Columbia River Basin area as used in this report occupies 176.3 million acres of land and water in the northwestern corner of the United States (Fig. 1). It includes all of the State of Washington, most of Oregon and Idaho, western Montana, and small parts of Wyoming, Utah, Nevada, and California. In northern Montana, a small part of the St. Marys River drainage tributary to Hudson Bay is included. The streams of Oregon and Washington which flow directly into the Pacific Ocean or Puget Sound are also included.

On the east the area is bounded by the Continental Divide in the Rocky Mountains, on the north by the Canadian border, and on the west by the Pacific Ocean. On the south the boundary approximates the southern rim of the Snake River, Harney Basin, Rogue River, and Chetco River watersheds. Some 23 million acres of the Columbia River drainage in Canada are not covered in this report.

For purposes of this report the above described area will hereafter be referred to as the Columbia River Basin, or as the Basi .

Population

The population of the Columbia River Basin area has grown from 1,174,000 in 1900 to over 4,614,000 in 1950, an increase of almost 300 percent in 50 years. Present trends indicate that a population of approximately 5,650,000 can be expected by 1960 and of 7,367,000 by 1975. (Fig. 2).

The rate of increase is greater than for the entire nation. Population in the Basin area increased by 33 percent from 1940 to 1950. During the previous decade the increase had been only 13 percent. The

increase from 1940 to 1950 had been attributed to many factors, but probably the most important were the war-created defense activities and the resulting demand for labor. With the end of the war, many people shifted into non-defense activities and remained in the area.

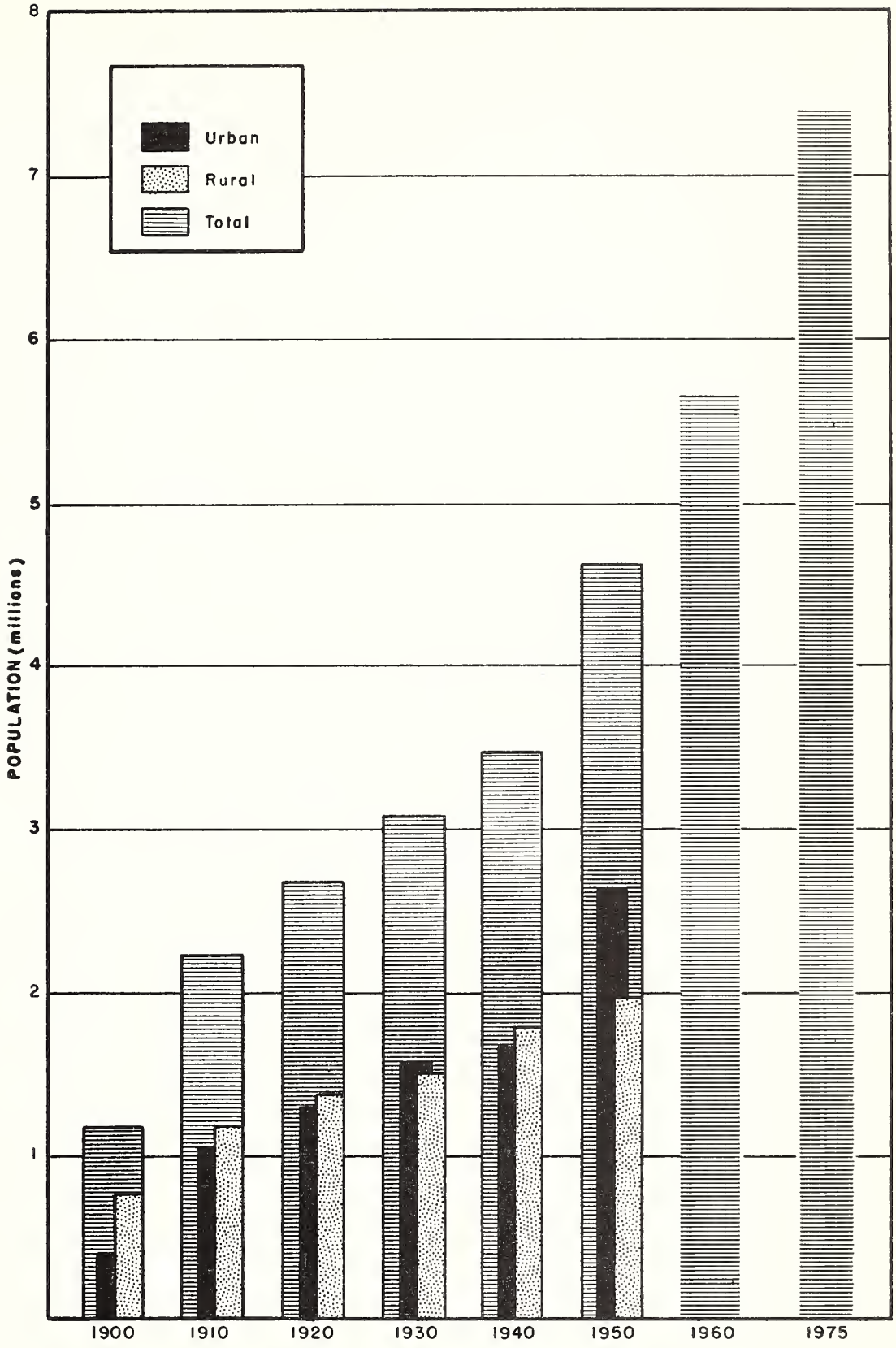
Population is concentrated primarily in the area west of the Cascades and in the irrigated valleys in the interior (Fig. 3). The density of population ranges from an average of one person per square mile to a high of 343 persons per square mile in King County, Washington. For the entire basin there is an average of 17 persons per square mile, a population density roughly one-third that of the United States as a whole.

The four largest cities, Seattle, Portland, Spokane, and Tacoma, have one-fourth of the total population of the entire Columbia River Basin. The cities with populations of 25,000 or more are listed in Table 1. In addition there are 31 cities with 10 to 25 thousand.

In 1950, only 43 percent of the population was rural. It is estimated that between 1940 and 1950, urban population increased by 37 percent while rural population increased by 30 percent. Although almost 2 million persons were included in the rural population, only 683 thousand of these, or approximately one-third, live on farms. The rural farm population is less than 15 percent of the total population.

Physiography

The Columbia River Basin is composed of several distinct physiographic provinces (Fig. 4). At the western edge is the Coast Range province, running north-south along the Oregon and Washington coast. It includes the Coast Range in Oregon and the Willapa Hills and Olympic Mountains in Washington. To the south, the Coast Range rises abruptly from sea level and in the Siskiyou Mountains reaches a height of 5,000



Population trends in Columbia River Basin Area with projections to 1975

Figure 2

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C A N A D A

P A C I F I C O C E A N

M O N T A N A

W Y O M I N G

C A L I F O R N I A

N E V A D A

U T A H

LEGEND

RURAL POPULATION

- 500 People
- Places of 1,000 to 2,500

URBAN POPULATION

- Places of 2,500 to 10,000
- Places of 10,000 to 25,000
- Places of 25,000
- Urbanized Area

NN

Figure 3

GENERALIZED DISTRIBUTION OF POPULATION
COLUMBIA RIVER BASIN AREA

1951

Data Obtained from Bureau of Census, Dept. of Commerce

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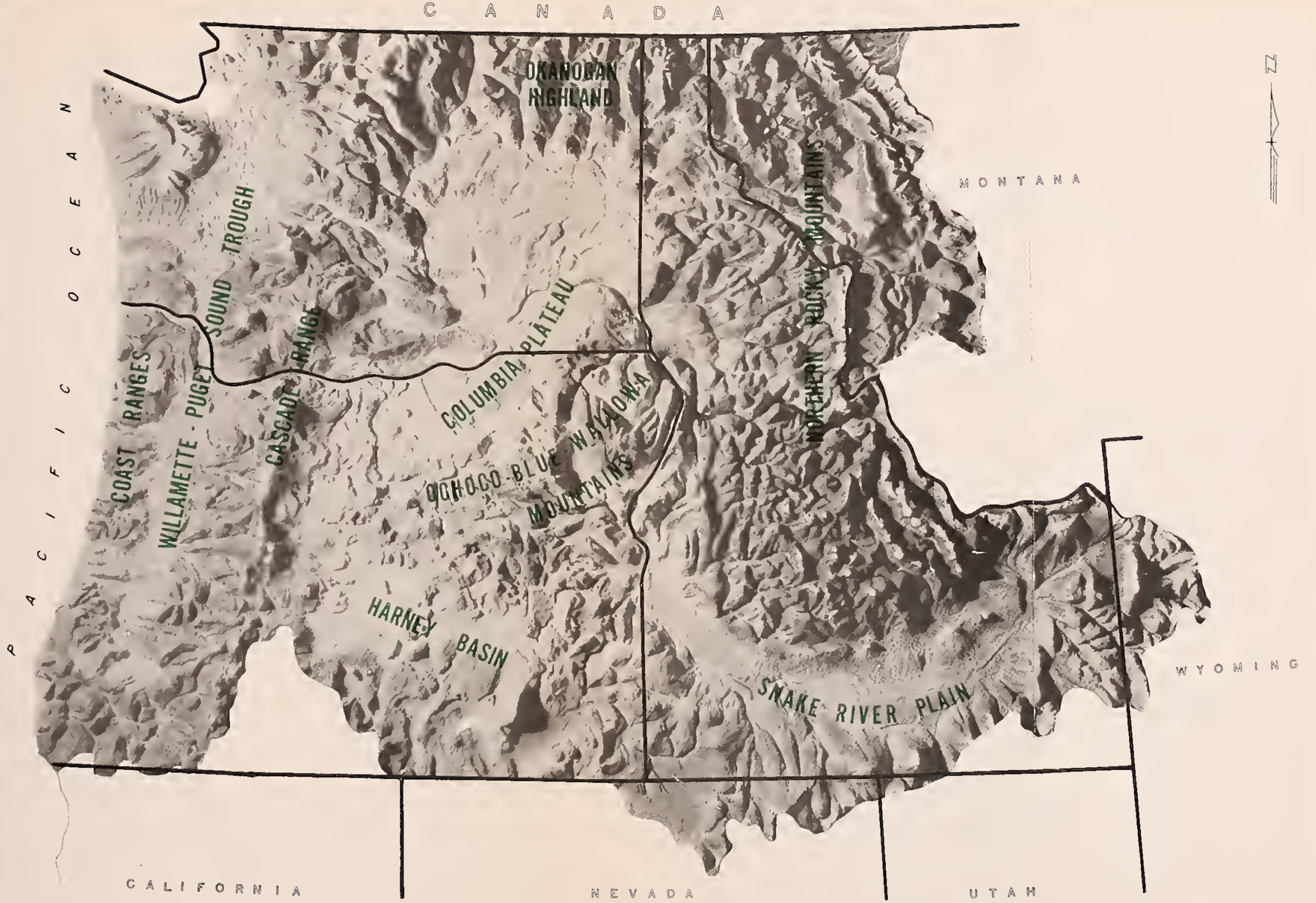


Figure 4

PHYSIOGRAPHIC PROVINCES

COLUMBIA RIVER BASIN AREA

1951

Relief Map by Bonneville Power Administration

Table 1.--Population of Major Cities of the Columbia River Basin Area, 1950

City	Population (thousands)	City	Population (thousands)
Seattle, Washington	468	Eugene, Oregon	36
Portland, Oregon	374	Boise, Idaho	34
Spokane, Washington	162	Everett, Washington	34
Tacoma, Washington	144	Bellingham, Washington	34
Salem, Oregon	43	Butte, Montana	33
Vancouver, Washington	42	Bremerton, Washington	28
Yakima, Washington	38	Pocatello, Idaho	26

feet or more. At the extreme northern end, the peaks of the Olympics rise to 8,000 feet. Most of the drainage from these coastal mountains is by short rivers running west to the Pacific Ocean. At its southern end, the Coast Range meets the cross ranges of the Siskiyous which extend east to the Cascades and provide part of the southern boundary of the Basin.

East of the Coast Range province and parallel to it is the Puget Sound-Willamette trough. This province lies below 1,000 feet elevation and is composed of drift and alluvial materials brought in by ancient glaciers and by present day streams. It is 30 to 50 miles wide and about 350 miles long. The Willamette River drains the southern half of the province, emptying into the Columbia River. The Lewis and Cowlitz rivers which are tributary to the Columbia, the Chehalis River flowing to the ocean, and the numerous rivers and streams emptying into Puget Sound drain the northern part.

The Cascade Range, the dominant feature of the western part of the Columbia Basin, forms the third province. This mountain block runs north-south, parallel to the two provinces just described. The main mass lies at about 5,000 feet elevation. Several volcanic peaks above 10,000 feet are included, with Mt. Rainier, at more than 14,000 feet, the highest. Except for the gorge cut by the Columbia River, this long mountain range separates the coastal from the interior portions of the Basin. It has a considerable influence on the climate.

Immediately east of the Cascades in northern Washington is the Okanogan Highlands province. It is composed of a series of north-south mountain ranges with peaks reaching from 5,000 to 7,000 feet elevation. The Spokane and Columbia Rivers mark the southern edge of this province which is drained by the Okanogan, Sanpoil, Kettle, and Colville Rivers.

The Columbia Plateau is the central province of the Basin. From elevations of 4,000 feet around the edges, it slopes gently down to less than 1,000 feet approaching the gorges of the Columbia and the lower Snake River. The surface of the plateau is flat to gently rolling, but is dissected by the channels of present-day streams and in the northern, eastern, and southern parts by deep coulees which are former channels of the ancient Columbia. The plateau extends from the upper curve of the Columbia south to the Blue Mountains in Oregon, east to the Rocky Mountains in northern Idaho, and west to the Cascades. It is drained by several small rivers tributary to the middle Columbia and to the lower Snake.

The Ochoco-Blue-Wallowa Mountains province lies in northeastern and central Oregon and in extreme southeastern Washington. Peaks in this mountain block reach elevations of 7,000 to 10,000 feet. The

area is drained by the John Day, Crooked, Umatilla, and Walla Walla Rivers flowing into the Columbia, and by the Grande Ronde, Malheur, Imnaha, Powder, and Burnt Rivers and other smaller streams tributary to the Snake.

Southernmost of the central provinces, the Harney Basin occupies a high plain dotted with volcanic cones and broken by fault-block troughs and short mountain ranges. This province extends across south-central Oregon from the Cascades almost to the Idaho border. The general base level is 4,000 feet, and the peaks reach from 6,000 to 9,000 feet. Small parts of the area are drained by the Owyhee and Malheur Rivers to the Snake, but most of the drainage is by small intermittent streams that disappear on the flat plain or empty into lakes which have no outlet.

To the east is the broad Snake River Plain, extending from southeastern Oregon across southern Idaho. The low mountain ranges of northern Nevada and northwestern Utah are included in the province, and form the southern boundary of the Columbia Basin. The eastern and northern edges of the area lie against the ranges of the Rocky Mountains. Elevations range from 3,000 feet along the Snake River to more than 10,000 feet on the peaks. Major drainages are those of the Owyhee, Bruneau, and Big Wood Rivers, all tributary to the Snake.

The Rocky Mountain province is the largest in the Basin and lies on the eastern edge of the Basin. It occupies western Montana, western Wyoming, and most of central and northern Idaho. It is composed of a series of mountain ranges generally oriented north to south. Between the ranges are narrow steep-walled valleys in which the major streams of the area flow. A few of the rivers have broad flat valley sections. Elevations vary from 3,000 feet in the valleys on the west to more than

10,000 feet on many of the peaks. The southern and western parts of the province are drained by the Snake and its principal tributaries, the Boise, Payette, Weiser, Salmon, and Clearwater Rivers. The northern part drains to the Columbia in Canada through the Clarks Fork and the Kootenai Rivers. In the northwest part, the Spokane River drains a considerable area to the middle Columbia.

Climate

West of the crest of the Cascade Mountains, a temperate humid maritime climate prevails. Summers are dry and moderately warm; winters are wet and mild. Extremes of heat and cold and destructive storms are rare. Topographic patterns determine climate. The valleys are warmest and driest, the mountains are coldest and wettest. Above 5,000 feet elevation most of the precipitation comes as snow.

In the central portion of the Basin, the climate is arid to semi-arid, with greater extremes of temperature both summer and winter. Low humidities and great amounts of sunshine characterize the area. While the climate is continental, it is modified by winds from the Pacific Ocean.

In the eastern part of the Basin the climate becomes more definitely continental, with summer rainfall from small localized storms. However, the climate is fairly dry. Temperature extremes are great, but excessively hot or cold spells are of short duration. The Snake River Plain province is much drier than the higher Rocky Mountains area.

Precipitation

Two factors control the precipitation pattern. One is nearness to the moisture supply (the Pacific Ocean) and the other is elevation. For the same elevation, the western parts receive the greatest

precipitation. For the same distance from the ocean, the higher mountains receive more than the plateaus and valleys (Fig. 5).

The heaviest precipitation in the United States occurs along the western slopes of the Coast Ranges where it reaches 200 inches or more annually in the Olympic Mountains. From the crest of the coastal mountains, precipitation decreases to about 35 inches in the Puget Sound-Willamette area, then rises again to 100 inches toward the crest of the Cascades. Here, heavy snowpacks have formed glaciers on many of the higher peaks. The variations in annual precipitation range from 60 percent to 150 percent of the average. Intensities rarely reach one inch in one hour, though several rainfalls from six to twelve inches in 24 hours have been recorded.

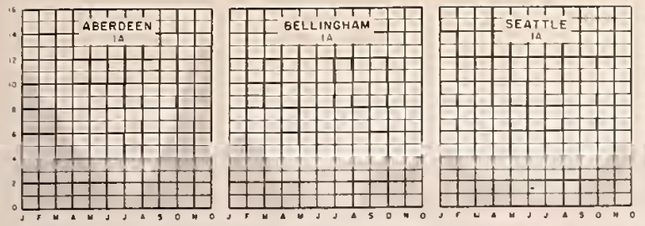
East of the Cascade Range, precipitation decreases rapidly to ten inches or less in the valleys and on the plateaus. Mountain areas of the central provinces receive 40 to 50 inches, much of it as snow. Spring and summer cloudburst storms are fairly common, and rainfall intensities often reach more than an inch an hour. Variation in annual precipitation ranges from 50 to 165 percent of the average.

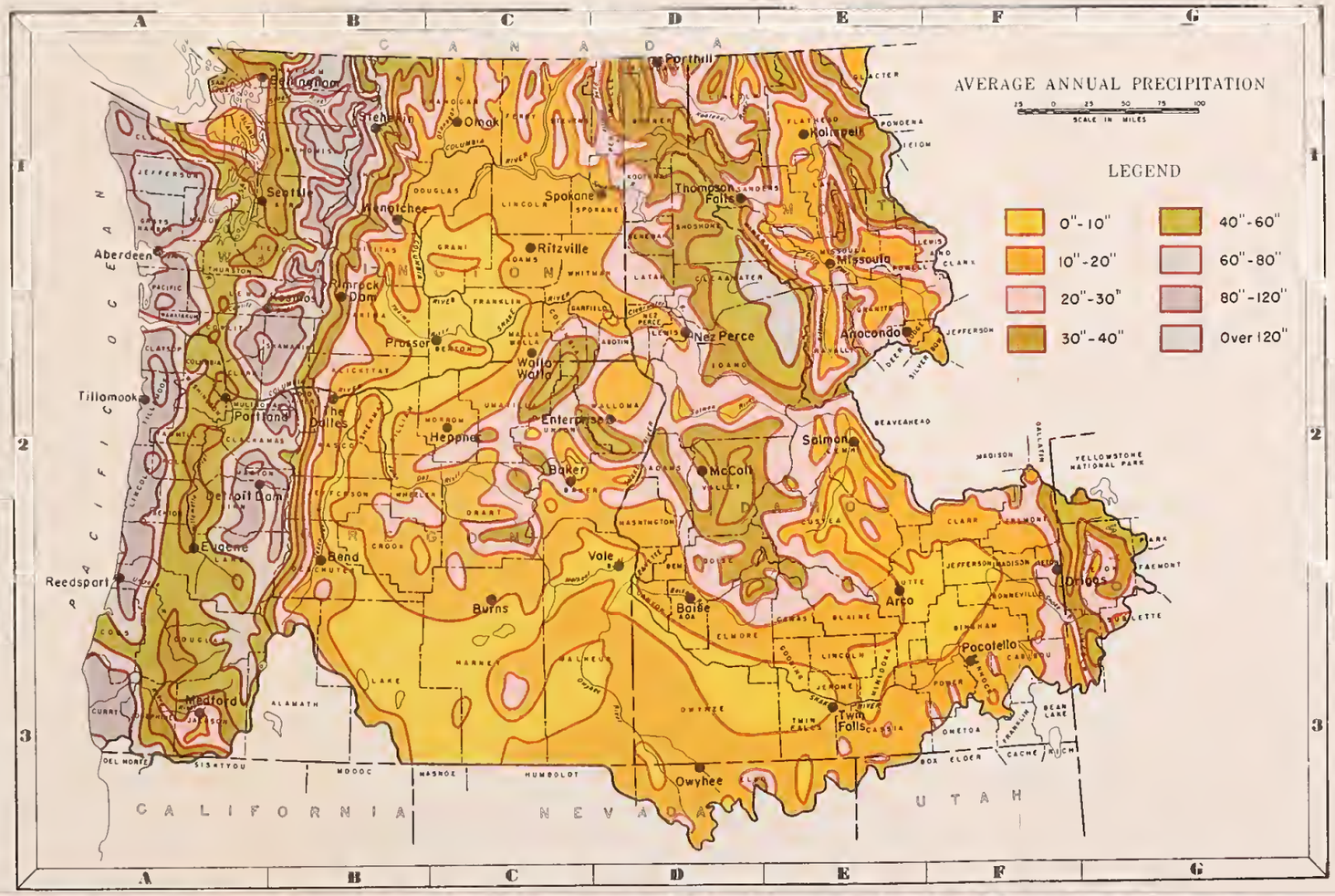
The Snake River Plain receives from six to fifteen inches of precipitation, and the Rocky Mountain province from 10 to 70 inches annually. Severe storms in winter and spring are common in both provinces. Extensive snowfields formed in the mountains in winter are the principal source of water for the streams of the region. Rainfall intensities as high as two inches per hour have been recorded and occasionally cause severe erosion and flash floods. Year to year variation in precipitation is similar to that of the central provinces.

Storms of two types, frontal and convective, occur throughout the Basin. Winter frontal type storms are widespread; they bring the long rains that are common to coastal areas and the heavy snows that build deep snowpacks in the mountains. They occur from fall to early spring and may last from four to nine days. Summer convective type storms are intense and of short duration and affect smaller areas. They may be accompanied by hail and strong winds that damage growing crops and cause flash floods.

If dry periods be defined as those of one month or more with less than one-half inch rainfall per month, the part of the Basin west of the Cascades suffers little. Along the coast, dry months occur nearly every year, but two-month periods occur only about once in ten years. In the Willamette-Puget Sound area, two-month dry periods occur once in three years, and three-month dry periods about once in ten years. Dryness here is generally more pronounced to the south. The central provinces have two-month or three-month dry periods nearly every year, and of four to six months' length from once in four to once in ten years. The eastern provinces are similar, with the mountain areas more humid than the plateaus and larger valleys. Dry summers are normal, but the occasional dry spring and fall seasons affect crop production adversely.

Annual variation in precipitation also is a matter of interest. Dry years with less than two-thirds the average precipitation occur about once in 30 years along the coast and in the Cascades, about once in 20 years in the Willamette-Puget Sound and Rocky Mountain provinces, once in 15 years in the central provinces, and once in 5 years in the Snake River area. Dry years may come in groups; the period 1928-30 was abnormally dry over most of the Columbia Basin. In contrast, the period 1948-50 was abnormally wet.





AVERAGE MONTHLY PRECIPITATION

Figure 5
PRECIPITATION
COLUMBIA RIVER BASIN AREA
1951

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Temperature

West of the Cascades, temperatures at low elevations range from a January average of 36° F to a July average of 62° F. The frost-free season is 200 t, 240 days long, from April to November. Daily variations are about 15° F in winter and 20° F to 25° F in summer. Extremes above 100° F or below 10° F are rare.

In the central provinces the January average temperature is from 20° F to 30° F, and the July average from 60° F to 75° F. Daily range in winter is from 15° F to 30° F, and in summer from 30° F to 50° F. Extremes well above 100° F and below -20° F are common. The frost-free growing season varies from less than 100 days in the high plateaus to 200 days in the lowest valleys.

The easternmost provinces have similar temperature conditions, but slightly more severe. January average temperature is from 15° F to 30° F, and the July average from 55° F to 75° F. Extremes of 120° F to -60° F have been recorded. The frost-free growing season varies from 80 days in the mountain valleys to 180 days in the western part of the Snake River Plain (Fig. 6).

Other Climatic Elements

Wind storms occasionally do damage to timber stands, agricultural lands and crops, public utilities, buildings, and industrial developments. Cold winds from the north and east bring mid-winter periods of freezing weather, while warm winds from the west and south accompany fall and winter storms. Hot dry winds from the east in summer and fall cause humidities to drop and bring on conditions of extreme forest fire danger. Wind velocities average from four to sixteen miles per hour over the Basin. Extremes over 100 miles per hour have been recorded along the coast. Prevailing wind movement is from the west.

Mountain snowpacks reach their greatest depth in March or April, and the general melt period begins a little later. Warm winds are a factor in the general snowmelt. Snowmelt runoff is greatest late in May or early in June. Normally, spring flood peaks in the Columbia River occur the first week in June. Mid-winter thaws in January and February often melt much of the snow at lower elevations and cause local flooding.

Evaporation is significant to agriculture. Mid-summer water losses in the interior provinces from eight to twelve inches per month have been observed at many places. West of the Cascades, highest losses are usually less than seven inches per month. High rates occur where the growing season is warm and windy. Under such conditions, rates of transpiration loss from plants are high.

A major climatic factor in the Basin is the occurrence of dry lightning storms which often start hundreds of fires in a single day and thus provide a constant threat to the protective cover of entire watersheds.

Water Resources

The water resources of the Columbia River Basin are among its greatest assets. The large amount of water readily available for irrigation, electric power generation, industrial and domestic use, and for other purposes, has been and will continue to be a significant factor in the development of the area. The volume of flow of the Columbia River itself is exceeded in the United States only by that of the Mississippi-Missouri River System.

Water Use

There are over 4 million acres of cropland under irrigation, and the Bureau of Reclamation estimates that nearly 4 million acres

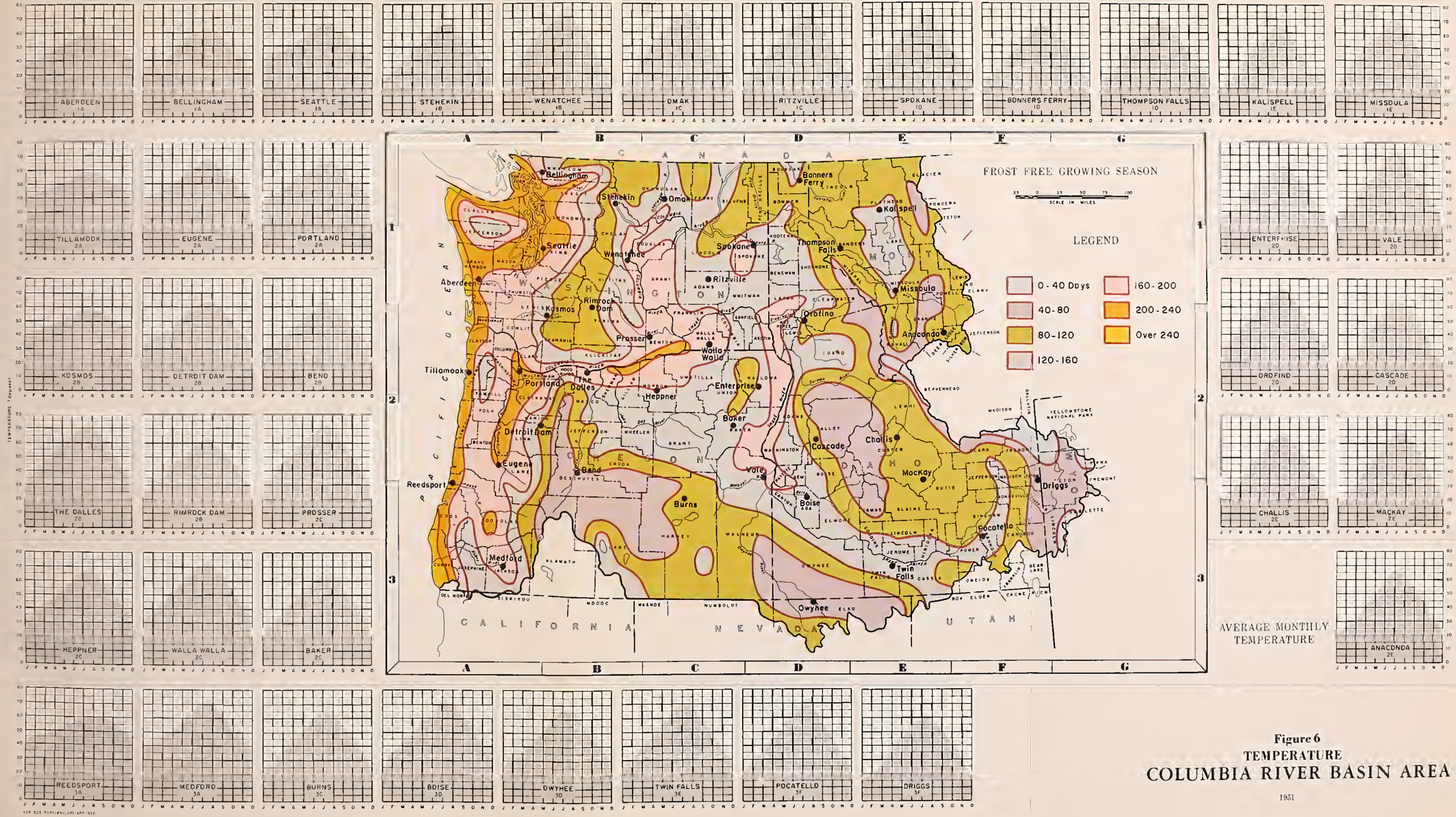

Figure 6

TEMPERATURE

COLUMBIA RIVER BASIN AREA

1951

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more can be irrigated. On range lands, availability of water is one of the important factors determining livestock distribution. Industrial development is contingent on availability of water, both as a raw material and for use in manufacturing processes. The large volume of water and the steep gradient of the river help to make the Columbia River the largest present producer and greatest potential source of hydroelectric power in the United States. Electric power is an extremely important factor in enabling farmers of this area to compete successfully with those closer to markets. Community existence and growth also depend on the presence of water. Recreation is in good measure tied to the location of water. The Columbia River and certain of its tributaries are the primary salmon-producing waters of the United States. Navigation on the larger waterways is important to commerce. All of these uses are built upon availability, dependability, and quality of the water supplies of the area. The water yield is vitally important.

Streamflow

Yields of the streams vary widely. Yields of some of the principal streams are shown in Table 2. In the driest years flows of the largest streams may average only 20 percent of the mean annual flow; in the wettest years, more than twice the mean. In the milder coastal climate the range in yields is much narrower than in the more arid interior provinces.

Seasonal variation in flow is high. Seasonal extremes range from no flow in some streams to more than 20 time the mean in others. West of the Cascades stream flow is usually high from October or November to April or May, dropping sharply during the dry summer. Eastward,

Table 2.--Water Yield of Representative Drainage Areas, Columbia River Basin Area

River	Drainage area	Average annual Yield: Depth on watershed	Volume	Extreme annual Yield: Minimum	Maximum
	Sq.Mi.	Inches	1,000 Ac. Ft.	% of average	% of average
Western Washington					
Skagit	2,970	74	11,700	63	121
Puyallup	914	48	2,320	65	154
Chehalis	897	38	1,830	62	143
Lewis	731	82	3,210	65	156
Quinault	264	137	1,940	66	136
Eastern Washington					
Wenatchee	591	50	1,590	58	152
Yakima	3,560	15	2,780	47	164
Colville	1,010	4	190	31	218
Spokane	4,350	22	5,010	36	150
Palouse	2,210	3	353	33	212
Northern Idaho					
Coeur d'Alene	1,220	26	1,689	45	166
Clearwater	9,570	20	10,645	58	165
Western Montana					
Clark Fork	10,500	9	5,190	50	163
Flathead	6,990	21	8,071	47	155
Kootenai	13,700	14	10,479	57	150
Western Oregon					
Rogue	2,020	18	1,982	42	160
Coquille (S. Fk.)	169	57	520	55	183
Umpqua	3,680	26	5,106	45	159
Siletz	202	106	1,142	63	141
McKenzie	930	53	2,636	68	146
Willamette	7,280	41	15,670	63	163
Eastern Oregon					
Deschutes	10,500	8	4,210	72	135
John Day	7,580	3	1,365	34	196
Owyhee	10,400	1	617	25	152
Umatilla	2,290	3	365	34	221
Grand Ronde	2,555	10	1,422	62	165
Southern Idaho					
Salmon	13,550	11	7,624	56	143
Boise	2,220	14	1,630	51	153
Bruneau	2,640	2	302	94	133
Snake	35,800	4	7,654	66	143
Big Wood	640	9	297	17	149
Henrys Fork	660	20	716	73	131
Columbia River at The Dalles	237,000	11	140,637	61	160

stream flow is high from March through July and is usually lowest in mid-winter.

Many streams are deficient in flow to meet needs for part of each year, and storage of excess winter and spring stream flow is necessary to increase the total usable yield. Sites are still available for providing additional storage for future power and irrigation development and other uses.

Water contributions from different physiographic provinces and different classes of land vary tremendously. In the Coast Range, the Willamette-Puget Sound trough, and the Cascade Range where the total precipitation is greatest, there are huge seasonal water surpluses. Eastward, the Okanogan Highlands and Rocky Mountain provinces produce significant volumes as river flow. The snowpack, caught and held in the upper watersheds, including those in Canada, furnishes the bulk of flow in the Columbia River. To the southeast much of the flow of the Snake River comes from the high mountain fringes which constitute but a relatively small part of that watershed. The Columbia Plateau, Harney Basin, and Snake River Plains receive limited precipitation and do not contribute much to total water yield.

Ground Water

Ground water is widely used for municipal water supplies, in industry, and as a source of domestic, livestock, and irrigation water. Unlike stream flow or surface water, ground water is generally more uniform in quantity, chemical quality, temperature, and other characteristics. Although ground water is intensively developed in a few small areas, the ground water resource has not been fully explored over more than 5 percent of the Basin. The

Willamette-Puget Sound trough area has several proven ground water basins. Potentials of ground water development in the Columbia Plateau are rather good with the advent of modern drilling equipment, low cost electric power, and efficient deep well pumps. Water found in the area is generally of good quality for most purposes. The presence of large springs in the Snake River Plain, together with records of wells scattered over much of the area, are indicative of ground water resources in the plain and adjacent foothill areas. However, depths to adequate amounts of ground water are several hundred feet over much of the area. Considerable ground water development is now underway in various parts of the Snake River Plain.

Soils and Geology

The rock formations of the Columbia River Basin are varied and mixed. The western coastal mountains are composed of old sedimentary sandstones, metamorphosed slates and schists, deeply weathered intrusive granite rocks, and old volcanic rocks. The Cascade Range is primarily volcanic basalts, breccias and andesites, with granitic and metamorphic rocks at the northern end. The Puget Sound area and many valleys of northeast Washington and northern Idaho have been filled with glacial debris scoured from the mountains in the United States and Canada. The central and southern provinces are underlain by vast areas of more recent volcanic basalts. A belt of granitic rocks extends across the Okanogan Highlands area and into Central Idaho. At the western end of the Snake River Plain and the southwestern corner of Columbia Plateau is a large area of old lakebed deposits, and a belt of deep wind-deposited material covers the eastern and

southern half of the Columbia Plateau. The Rocky Mountains are made up primarily of sedimentary and metamorphic rocks, with the valleys between the ranges filled with alluvial glacial material.

The great variety in the parent rocks has had a considerable effect on soil development (Fig. 7). In the coastal areas, on the marine sedimentary and the lava rocks, the soils are heavy in texture and acid in reaction. The gravelly glacial drift of the Puget Sound region has produced some lighter-textured soils. In the Willamette Valley the alluvial soils are of medium to heavy texture, with moderately heavy textured residual soils developed from the underlying lava rocks on the hills and benches around the valley. The high rainfall belt of the Cascades has medium to light-textures "shot" loam soils on the basalts and heavy loams with clay subsoils on other volcanic formations.

The granites and sedimentary rocks east of the Cascades have developed sandy loams that are readily eroded when exposed to wind and water. The lakebed and wind-deposited soils of the central portion of the basin range from silt loams to clay loams; these too, are easily eroded when misused. Metamorphosed rocks of the Rocky Mountain province have developed soils generally medium in texture and fairly stable. Heavy textured soils are found on the finer-grained sedimentary rocks. The lavas of the Snake River Plain support medium textured erodible loam soils with heavy subsoils. Soils derived from other formations of the area cover a wide range of textures and fertility, and nearly all are rather highly erodible.

The alluvial soils of the valleys, and the wind-deposited soils of the Columbia Plateau and Snake River Plain are the best for agriculture, being quite fertile. The majority of the wheat crop of the

interior portion of the Basin is grown on the wind-deposited soils, while the alluvial soils are the basis for an intensive irrigated agriculture.

Land Capability

Land capability is the ability of the land to produce permanently under specified uses and treatments. Land capability classification is based principally on physical characteristics of slope, soil depth and texture, but also includes climatic limitations. In this classification the best land is that which will allow the most intensive cultivation and require the least in special management and treatment practices. Conversely, the poorest land is that which is most restricted in its use and requires the most in special management and treatment practices.

The classification has eight classes of land to indicate the intensity of conservation problems and the maximum feasible intensity of use. There are four subclasses to indicate the dominant problems - erosion hazard, wetness, soil deficiency, or climatic limitation. Classes I, II, III, and IV include lands suitable for cultivation. Classes V, VI, and VII include lands not suitable for cultivation but are suitable for permanent vegetation, either range or woodland. Class VIII includes lands not suitable for cultivation or the production of harvestable forage or woodland products, but may be suitable for wildlife, recreation, or watershed protection purposes. (Fig. 8 and Table 3).

Land Suitable for Cultivation

Class I land is very good land which has deep soil, is nearly level and has no serious hazards or limitations. It needs practices to maintain soil fertility, soil tilth, and moisture intake capacity.

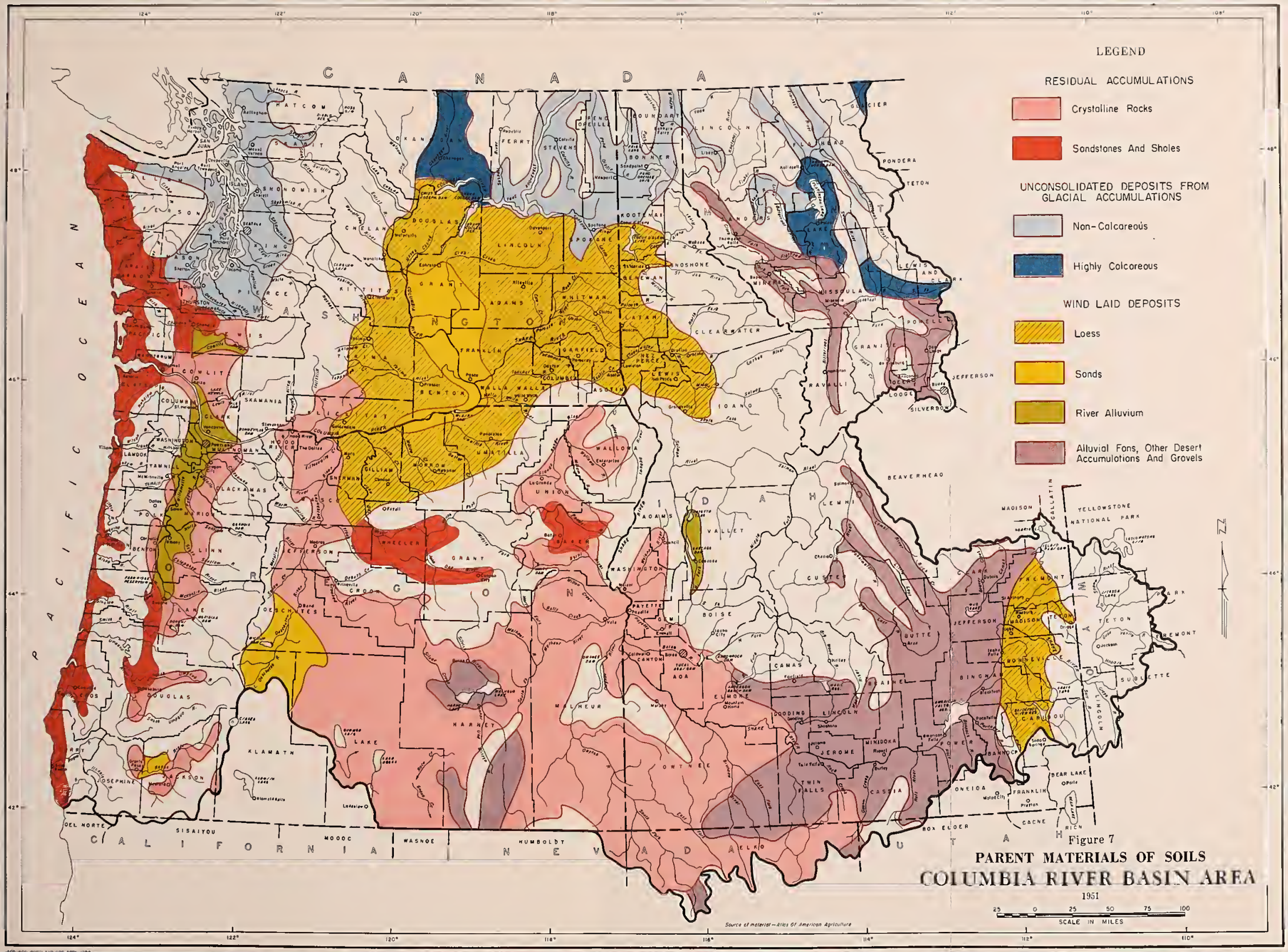


Figure 7

PARENT MATERIALS OF SOILS

COLUMBIA RIVER BASIN AREA

1951

LAND SUITED FOR CULTIVATION

I — Very good land with little or no limitation or hazard. It is nearly level, deep and without erosion. Some of it may need drainage, clearing or other conditioning measures.

II — Good land with only minor limitations or hazards such as, gentle slopes, moderately shallow soils or slight susceptibility to erosion. Choice in use may be reduced, and conservation practices such as water management, contour operation, cover cropping, etc., are required.

III — Moderately good land with major physical limitations and hazards. It usually is characterized by relatively steep slopes, shallow soils or severe erosion problems. Choice in use is limited and protective measures such as terracing, strip cropping and careful water management, are necessary.

IV — Fairly good land which is suitable for occasional cultivation—usually not more frequently than 1 year in 4. When plowed, considerable care needs to be taken to avoid erosion or other lasting damage.

LAND NOT SUITED FOR CULTIVATION

V — Very well suited for grazing or forestry use. It has little or no physical limitations or hazards when so used but requires good range or woodland management.

VI — Well suited for grazing or forestry use. It has minor hazards and limitations due to moderately steep slopes, shallow soils or susceptibility to erosion.

VII — Fairly well suited for grazing or forestry use. It has major hazards or limitations because of very steep slopes, shallow or droughty soils, or advanced erosion.

VIII — Land unsuited for agricultural purposes, but may be used for wildlife, recreational or watershed purposes.

Refer to text for description

THE LAND USE CAPABILITY CLASSES

All land is divided into eight broad classes. The first four classes, in Indo land which can be plowed and cultivated safely, without lasting damage, if correct conservation procedures are followed. Class I land needs little special conservation treatment. Classes II, III and IV require increasing degrees of care and protection. The remaining four classes are not suited for cultivation. They need the protection afforded by a permanent cover of vegetation. Classes V, VI and VII require progressively more care even when used for grazing or forestry. Class VIII land can be used safely only for wildlife, recreation or watershed purposes.

Figure 8

GENERALIZED LAND USE CAPABILITY
COLUMBIA RIVER BASIN AREA
1951

SCALE IN MILES 25 0 25 50 75 100

U.S. DEPARTMENT OF AGRICULTURE

It includes well-drained bottoms and associated bench lands along rivers and streams and very gently sloping or nearly flat plateaus having deep loamy soils.

Class II land is good land that can be cultivated safely with easily applied conservation measures. It is subject to moderate limitations in use or risks of damage because of one or more of the following conditions: gentle slopes, moderate susceptibility to erosion, moderate soil depth, somewhat unfavorable soil texture and workability, moderate wetness correctible by drainage, slight concentration of toxic salts, or minor soil deficiencies. These lands include nearly level first bottoms and higher benches along rivers and streams, ancient lake bottoms and terraces, and some gently sloping lands.

Class III land is moderately good land that can be used for crops in proper rotation. It requires intensive application of conservation practices. It is subject to severe limitations because of one or more of the following conditions: moderate slopes, high susceptibility to erosion, continuing hazard of excessive wetness, shallow soil, low moisture holding capacity, severe alkalinity or salinity, or low inherent fertility. Most of this land is located on moderately steep slopes of the Palouse and Blue Mountain area and the summer fallow wheat area of central Washington, northern Oregon and southeastern Idaho. It includes also the land with moderate slopes and soil limitations in the irrigated areas, the wet bottom lands subject to overflow, and the moderately sloping hill lands of the Pacific slope and other subhumid areas.

Class IV land is fairly good land that is best maintained in perennial vegetation which can be cultivated occasionally. It is

Table 3.--Acreages of Land by Use and Capability Class
Columbia River Basin Area, 1950

Capability class	Land use			
	Cropland	Non-forested range	Forest	Total
	1,000 Acres	1,000 Acres	1,000 Acres	1,000 Acres
I	591	7	23	621
II	5,961	341	223	6,525
III	6,907	893	899	8,699
IV	4,439	2,197	3,003	9,639
V	59	852	591	1,502
VI	565	34,918	30,289	65,772
VII	4	23,999	47,215	71,218
VIII	0	1,051	2,312	3,363
Total	18,526	64,258	84,555	167,339 1/

1/ The 7,183,000 acres not accounted for in this classification includes areas occupied by cities and towns, roads, railroads, airports and other miscellaneous uses.

subject to very severe limitations because of moderately steep slopes, serious erosion potential, unfavorable soil characteristics, or adverse climate. The major areas of this class are located on the old coastal marine terraces and glacial plains west of the Cascade Mountains. It is also found on the margins of the summer fallow wheat belt of Oregon, Washington, and Idaho, where climate is the limiting factor.

Lands in Classes I to IV are also suitable for the production of farm wildlife including game birds and mammals, waterfowl, fur bearers, and birds that destroy insect pests, rodents or weed seeds. Lands in these capability classifications are frequently used for wildlife production purposes.

Land Not Suited for Cultivation

Land Capability Classes V, VI, and VII are primarily best suited to forestry use in the areas of higher rainfall, to grazing use in areas of low rainfall and to multiple use in the intermediate rainfall zone. These classes of land are all suited to various kinds and degrees of wildlife use. Due to hazards of or limitations in production, management or use, the productive capacity of the lands generally declines as the class increases.

Class V land may be very well suited to grazing or to wildlife, forestry or to multiple uses with few or no permanent limitations for such uses. It usually has deep productive soils, it may be nearly level or slightly sloping, but has either a high water table or large stones which makes cultivation impossible.

Class VI land is well suited to grazing or to forestry or to wildlife or for multiple use under careful management. It may be too steep, or subject to serious erosion, or too wet or too dry, or with shallow soils, any of these would make it unsuited for cultivation. It may have slight to moderate hazards depending on the use to which it is put.

Class VII land is fairly to moderately well suited to forestry, grazing use, wildlife use, or multiple use due to hazards in production, management or harvest. It may contain deep soils or steep slopes, or be eroded, rough, shallow or dry, or have other characteristics which would limit the growth, utilization, or management of the vegetation.

Class VIII land is suitable only for wildlife, recreation, or watershed protection due to limitations or hazards which make it unfit for cultivation, grazing, or forestry use.

Land Cover, Use and Ownership

The vegetative cover on the land has resulted from the combined effects of natural factors and man's activities. Among the natural factors which influence land cover are: geology, topography, precipitation, wildlife population, and naturally set fire occurrence. Man's activities include: clearing, cultivation, irrigation, logging, livestock grazing, fires, transportation and urban developments.

The use of land has evolved as a result of natural limitations and man's efforts and is a generalized indicator of cover type. However, there are many variations in kind and density of vegetation within each type of use. Land use types as shown in Figure 9 are cropland, rangeland, forest land and other. Figure 10 and Table 4 show the generalized use of the land within the Columbia River Basin by ownership.

Cropland

There is a wide variation in the vegetative cover on the 18.5 million acres of cropland in the Columbia River Basin. This variation is due largely to the diversity of crops grown and the management practices used in growing these crops. Crops grown include decidious fruits, nuts, and berries; row crops, such as potatoes, sugar beets, and truck; grain and other close seeded crops; and sod crops, such as hay or pasture in a rotation. Some lands are fallow each year. Table 5 shows the distribution of cropland use by states, and Table 6 shows the irrigated and non-irrigated areas by states.

The amount of effective cover on the land also varies considerably by geographic areas within the Basin. West of the coastal

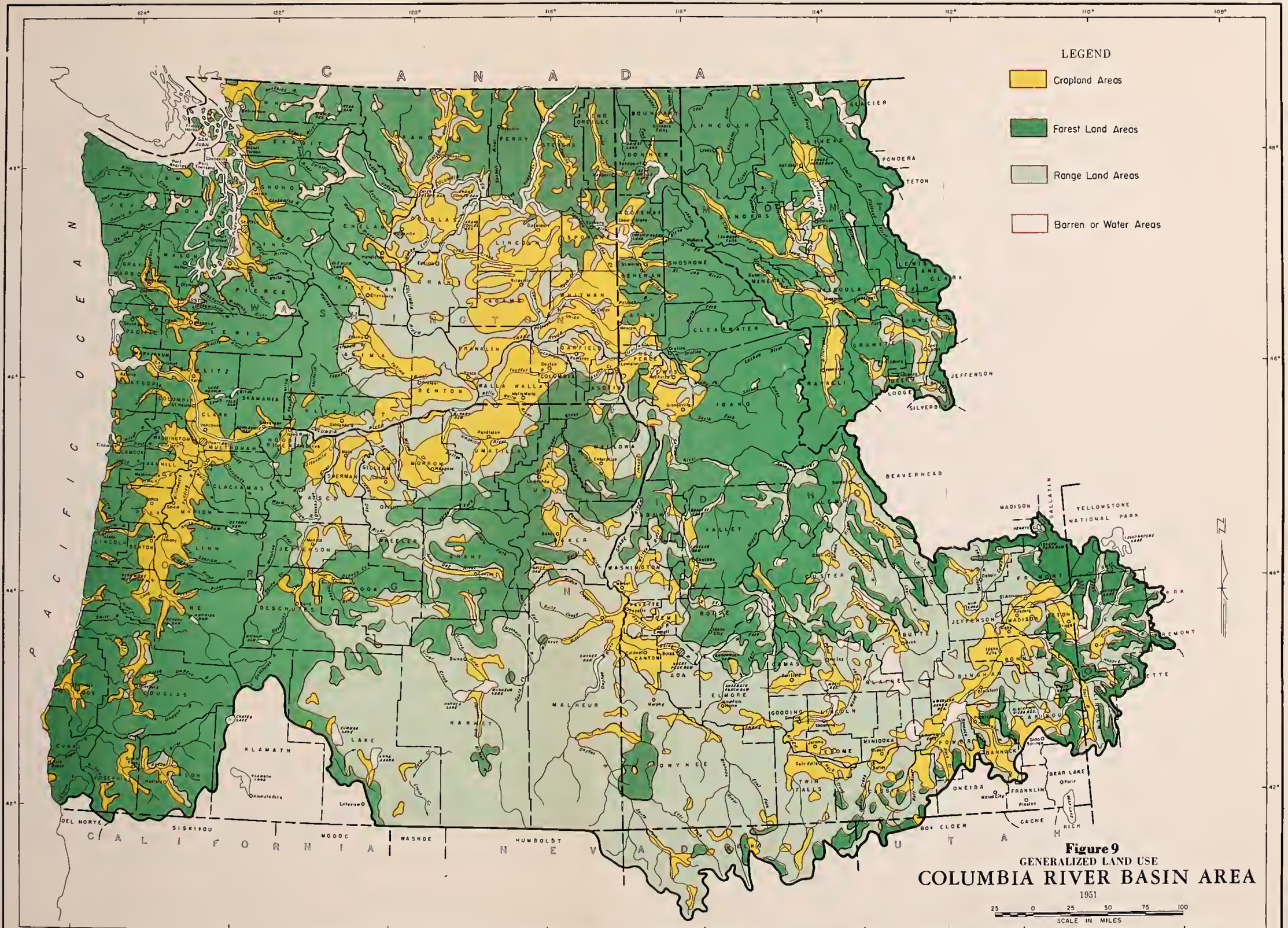
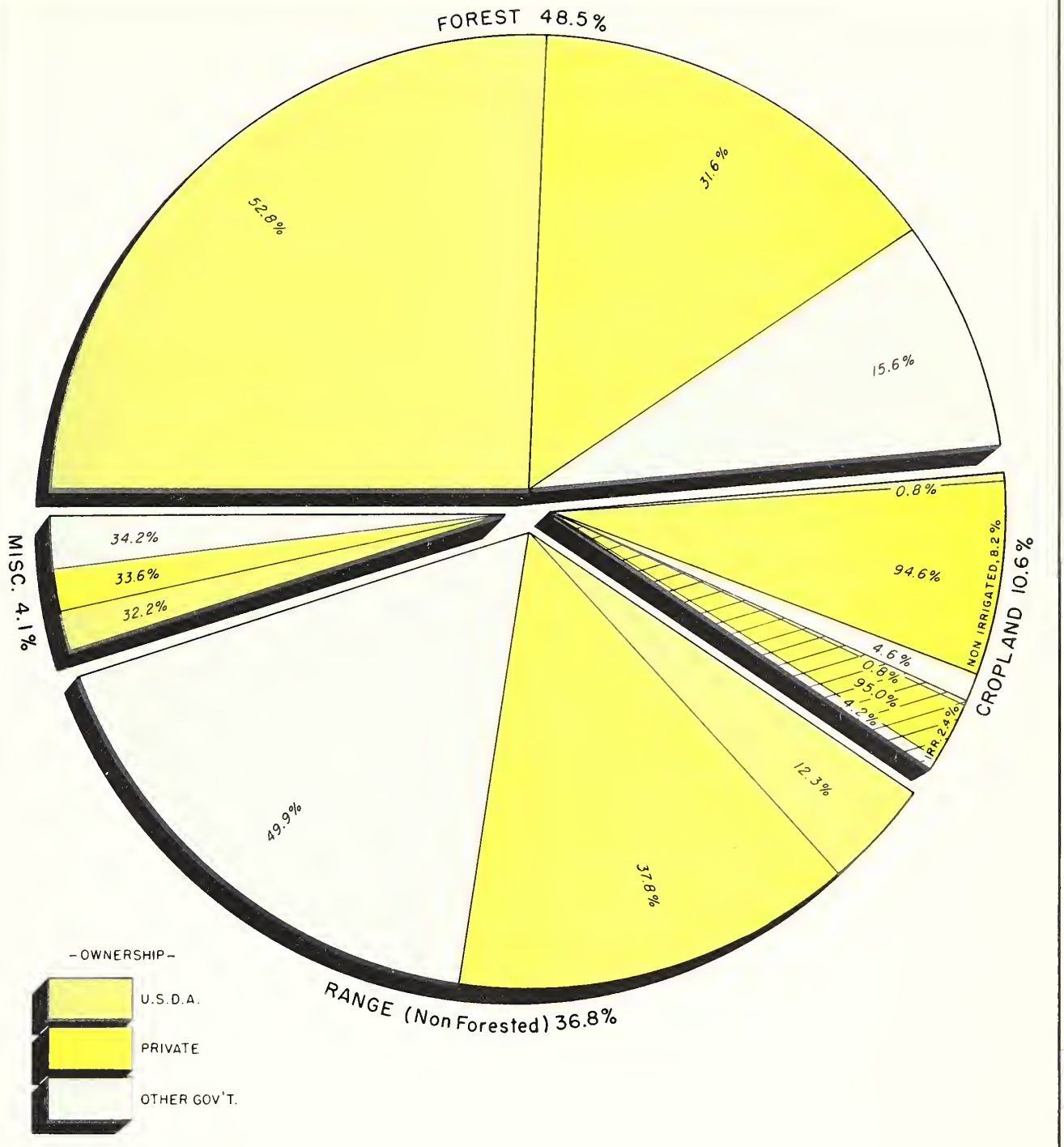


Figure 9

GENERALIZED LAND USE

COLUMBIA RIVER BASIN AREA

1951



LAND TYPE AND OWNERSHIP

COLUMBIA RIVER BASIN AREA

July , 1952

Table 4.--Acres of Land by Ownership and Land Use Type
Columbia River Basin Area, 1950

Type of ownership	Land use type					
	Forest	Non-forested range	Cropland		All other	Total
			Irrig.	Non-irrig.		
	1,000 Acres	1,000 Acres	1,000 Acres	1,000 Acres	1,000 Acres	1,000 Acres
Federal						
USDA	44,687	7,916	3	12	2,313	54,931
USDI	8,948	27,675	198	533	2,185	39,539
Other Federal	70	853	0	1	54	978
Subtotal	53,705	36,444	201	546	4,552	95,448
State and Local						
State	4,011	3,454	8	196	204	7,873
County and Municipal	197	12	0	0	9	218
Subtotal	4,208	3,466	8	196	213	8,091
Private 1/	26,642	24,348	3,896	13,679	2,418	70,983
Total Land Area	84,555	64,258	4,105	14,421	7,183	174,522
Water Surface Area						1,800
Total Area						176,322

1/ Includes County and Municipal lands not under specific management.

range, over two-thirds of the cropland is used for grass crops. On the semiarid Columbia Plateau, over 40 percent of the cropland is annually in fallow, which leaves it practically bare of vegetative cover. Orchards occupy about 7 percent of the cropland in the central Washington valleys and in the Willamette Valley in Oregon. Nearly half of the row crops in the basin are grown on the Snake River Plain, where potatoes and sugar beets are the major crops. Small grains are grown on from one-fourth to one-half of the cropland in all areas except on the coastal section and the closed basin.

Table 5.--Acres of Cropland by Generalized Use Classes
Columbia River Basin Area, 1950

State	Generalized use classes					
	Orchards[1/]	Row Crops	Close seeded crops	Sod crops	Fallow	Other misc.
	1,000 Acres	1,000 Acres	1,000 Acres	1,000 Acres	1,000 Acres	1,000 Acres
California	0	0	0	0	0	0
Idaho	16.4	407.1	2,126.1	1,323.0	667.7	87.1
Montana	2.0	13.0	213.8	402.5	66.3	5.0
Nevada	0	0	2.2	75.0	0	0
Oregon	161.8	143.7	1,995.1	1,593.1	997.0	309.4
Utah	0	0	2.3	9.2	.5	0
Washington	142.7	169.0	3,428.0	1,238.4	2,468.8	349.5
Wyoming	0	.4	27.4	77.7	5.0	0
Total	322.9	733.2	7,794.9	4,718.9	4,205.3	751.0

1/ Orchards as used in this table include cropland planted to bearing and nonbearing tree fruits, nuts, hops, vineyards and cane or bush fruits, excluding noncommercial family plantings.

Table 6.--Irrigated and Nonirrigated Cropland
Columbia River Basin Area, 1950

State	Irrigated cropland	Nonirrigated cropland	Total cropland
	1,000 Acres	1,000 Acres	1,000 Acres
California	0	0	0
Idaho	1,920	2,708	4,628
Montana	354	349	703
Nevada	70	7	77
Oregon	1,072	4,128	5,200
Utah	8	4	12
Washington	589	7,207	7,796
Wyoming	92	18	110
Total	4,105	14,421	18,526

Table 7.--Acres of Range by Types and by Ownership
Columbia River Basin Area, 1950

Type of ownership	Nonforested range	Forested range	Total range
	Million acres	Million acres	Million acres
Federal:			
Dept. of Agriculture	7.9	31.3	39.2
Dept. of Interior	27.7	6.3	34.0
Other public	4.4	3.0	7.4
Private	24.3	18.6	42.9
Total	64.3	59.2	123.5

Rangeland

The rangelands of the Columbia River Basin comprise about 64.3 million acres of nonforested land (Table 7). About 70 percent of the forested land (59.2 million acres) also supports livestock, big game and other wildlife.

There are three general types of rangeland. The characteristics of each are influenced by climate, soils, and elevation. The summer ranges at the higher elevations are characterized by large expanses of open grassland, perennial weeds, and browse on side slopes and ridgetops, with groups of trees interspersed in the ravines and on the northern exposures. Some of these areas are mountain meadow and meadow type range along stream bottoms. The cover is predominantly succulent forbs, both annual and perennial, grasses and grasslike plants, and shrubby browse plants. Some of this range is heavily grazed by sheep and cattle during the summer

months, and during a more extended season by big game animals such as deer and elk. In some areas, as a result of heavy grazing, the native perennial grasses, sedges, and more palatable forbs have been largely replaced by less palatable plants.

The open rangelands just below the lower fringes of the timbered areas and at intermediate elevations have more extensive grasslands than the summer range. These areas furnish spring and early summer feed for livestock and winter forage for big game. Originally, they supported perennial grasses and sedges. Because of overuse, the cover over wide areas now consists of inferior species and is not sufficiently dense to hold the soil. Cheatgrass, an annual of short seasonal life, is one of the chief invaders. Sagebrush and noxious weeds also are much more common than formerly.

Vegetative cover on the more gently sloping rangelands at lower elevations and the intermediate plains country is characterized by grasses, forbs, and sagebrush. These lands include plateaus, river bottoms, and flats and benches. Here again, over extended areas, fire and grazing pressure by both domestic stock and big game animals has resulted in a replacement of the perennial grasses and shrubs by cheatgrass and annual weeds. Noxious weeds, including goatweed, halogeton, and Medusa-head wildrye, are prevalent in parts of these areas.

The condition of rangelands varies considerably over the Basin area. About half of the nonforested rangeland is in poor condition to retard surface runoff, reduce sediment production or produce forage. Generally these lands have little protection against soil erosion and have a low water intake rate (Table 8).

Table 8.--Condition Classes of Range Cover Types Usable by Livestock Columbia River Basin Area, 1950

Range cover types	Condition class			
	Good	Fair	Poor	Total
	(Millions of acres)			
Mountain brush	0.7	1.4	1.5	3.6
Sagebrush-rabbitbrush-desert shrub	4.7	11.7	18.5	34.9
Perennial grasses and forbs	4.4	6.2	6.4	17.0
Meadow	0.4	0.6	0.6	1.6
Annuals	1.1	1.8	4.3	7.2
Total nonforested range	11.3	21.7	31.3	64.3
Forested range	19.5	22.4	17.3	59.2
Total forested and nonforested range	30.8	44.1	48.6	123.5

Forest Land

About 48 percent, or 84.6 million acres, of the Basin is forest land; that is, either with 10 percent or more tree cover, or land from which trees have been removed but which is used primarily for timber production, or land with brush cover which influences water yields. Nearly 54 million acres are owned and administered by the Federal Government, 4 million acres by state government, and 26.6 million acres are in private ownership. Private lands include a major part of the best timber-growing sites.

Three commercially important timber types cover the bulk of the forest area. The Douglas fir type occupying 33 million acres is the predominant type west of the Cascades. The ponderosa pine type occupies nearly 17 million acres and is located largely in the foothills and lower mountains east of the Cascades. Western white pine occupies 4 million acres and is concentrated largely in the mountains of northern Idaho. (See Figure 11).

Becoming important commercially as access and utilization improve and as the more desired species become less available are the lodgepole pine type and the spruce, fir and hemlock types. The lodgepole pine type occurs primarily in the Rocky Mountains, but small areas are scattered throughout the Cascades and Blue Mountains. It occupies over 9 million acres. The spruce, fir and hemlock types cover the higher elevations in the Cascades and Blue Mountains and are scattered over the western Rockies. It occupies 7.5 million acres.

Noncommercial forest, generally made up of thin stands of poor quality timber at the higher and less accessible elevations, covers nearly 12 million acres. It is important primarily for watershed

protection. At lower elevations, and the fringes of the open range in the southern portion of the Basin, the juniper type occupies over one-half million acres. Some of the juniper is used locally for fuel and fenceposts. The western hardwoods type occurs in small patches scattered over the Basin, but for the most part in coastal areas. It includes alder, cottonwood, aspen, maple, oak, madrone, and chinquapin and occupies a little over a million acres. Some of the hardwoods are used for furniture making, some for fuelwood, and some for paper pulp.

The Douglas fir type west of the Cascades is the basis for a large part of the lumber industry in the Basin. With its associated species, western hemlock, Sitka spruce, western redcedar, and the true firs, it supplies great volumes of wood for all kinds of lumber, veneer, paper pulp, fuel, and a variety of minor uses. East of the Cascades, Douglas fir and the associated larch, Engelmann spruce, and true firs are considered less desirable but still are used in quantity. In the interior of the Basin, ponderosa pine and western white pine are the prime commercial timber species, and are the mainstay of the lumber industry in that area.

In addition to providing the renewable timber resource on which a large segment of the Basin economy is based, the forest land also is the prime source of water for the streams of the area. Forest cover is important in relation to regulation of snow accumulation, snowmelt, streamflow peaks, water quality, and water supply for municipalities, industry and for millions of irrigated acres of cropland. Much of the forest land, particularly in the ponderosa pine type, produces forage for livestock and big game. The forest land is also used extensively for recreation and is a significant tourist attraction.

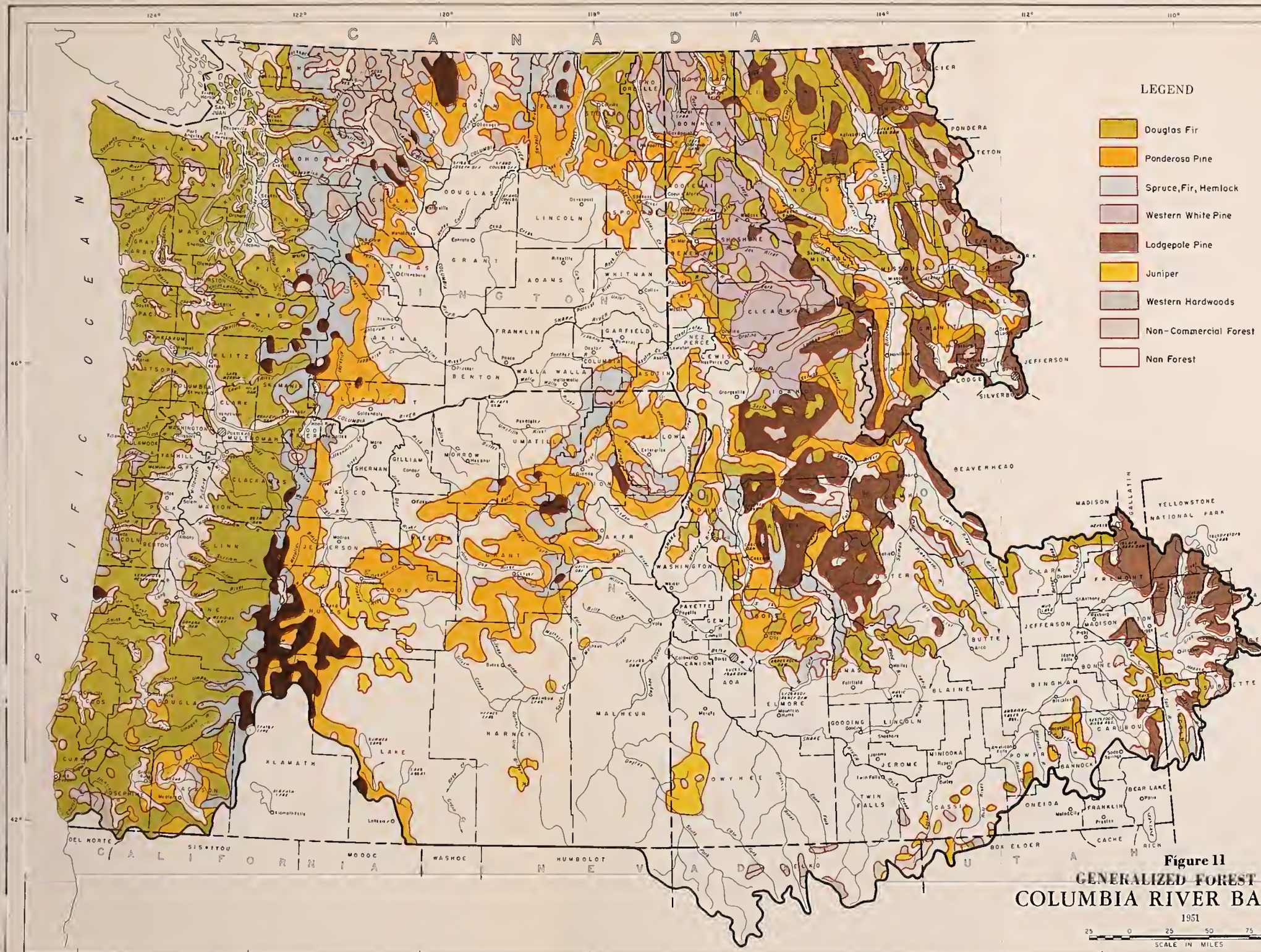


Figure 11

GENERALIZED FOREST TYPES

COLUMBIA RIVER BASIN AREA

1951

Farm Land

The present stage of farm land use has been reached after slightly more than a century of development. There was some farming on a small scale in the western part of the Basin in the late 1820's and 1830's, but the great migration to western Oregon and western Washington did not get under way until the 1840's. Settlement in the eastern part of Washington did not begin until the late 1850's, with settlement beginning in eastern Oregon and Idaho somewhat later. The beef cattle industry was the first enterprise developed in the eastern area, but it did not take long for the settlers to discover that parts of the area were highly productive of wheat. Throughout the valleys of Idaho irrigation was practiced from the very beginning of settlement.

The range livestock industry in southern Idaho, western Wyoming and Montana, and in eastern Washington and Oregon was developing rapidly by 1870. Livestock numbers increased greatly during the next 30 years. Since 1918, sheep numbers have declined markedly. For example, in southern Idaho the number of sheep declined from 2,650,000 in 1918 to 1,109,000 by 1950. Over the same period of time cattle use of the grazing lands has increased.

Although 9.2 percent of the total land area of the United States is in the Columbia River Basin, only 4.5 percent of the land in farms is in this area. Other relationships are shown in Table 9.

In 1950, 173 thousand farms were in the Basin. This is a decline from the peak of 199 thousand farms reported in 1935. Average size of these farms in 1950 was 301 acres per farm as contrasted with 220 acres per farm in 1935. Farms with irrigated

Table 9.--Comparison of Select Agricultural Statistics
United States & Columbia River Basin Area, 1949-50

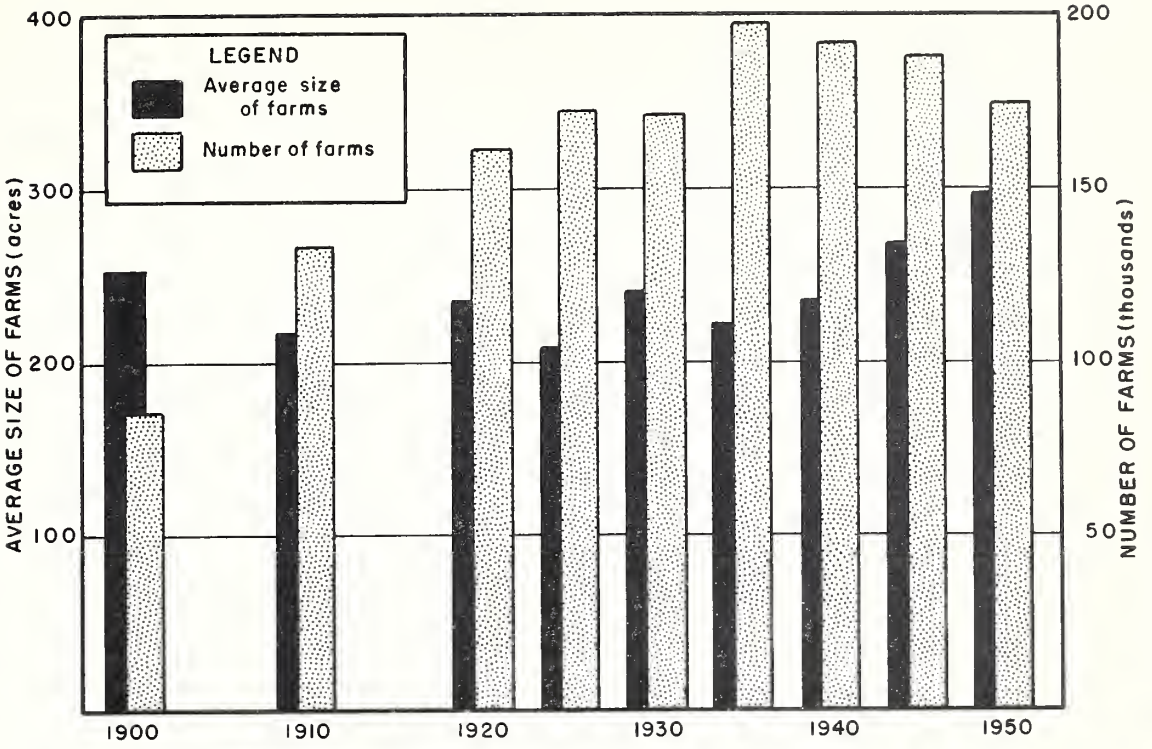
Item of comparison	Unit	United States	Basin	Percent Basin is of U.S.
Net land area	mil. acres	1,904	175	9.2
Land in farms	mil. acres	1,159	52	4.5
Land area in farms	percent	60.9	29.9	-
Cropland, all	mil. acres	478	18	3.9
Cropland harvested	mil. acres	344	11	3.2
Irrigated land	mil. acres	26	4	15.9
Number of farms	1,000	5,382	173	3.2
Number of commercial farms	1,000	3,706	108	2.9
Value of farm products sold	mil. dollars	22,052	943	4.3
Total population	1,000	150,697	4,614	3.1
Rural population	1,000	54,230	1,982	3.7
Rural farm population	1,000	23,332	683	2.9

lands averaged 351 acres in 1950. Although the average size of all farms was 301 acres, almost half of the farms reported in the census in 1950 had less than 50 acres (Fig. 12).

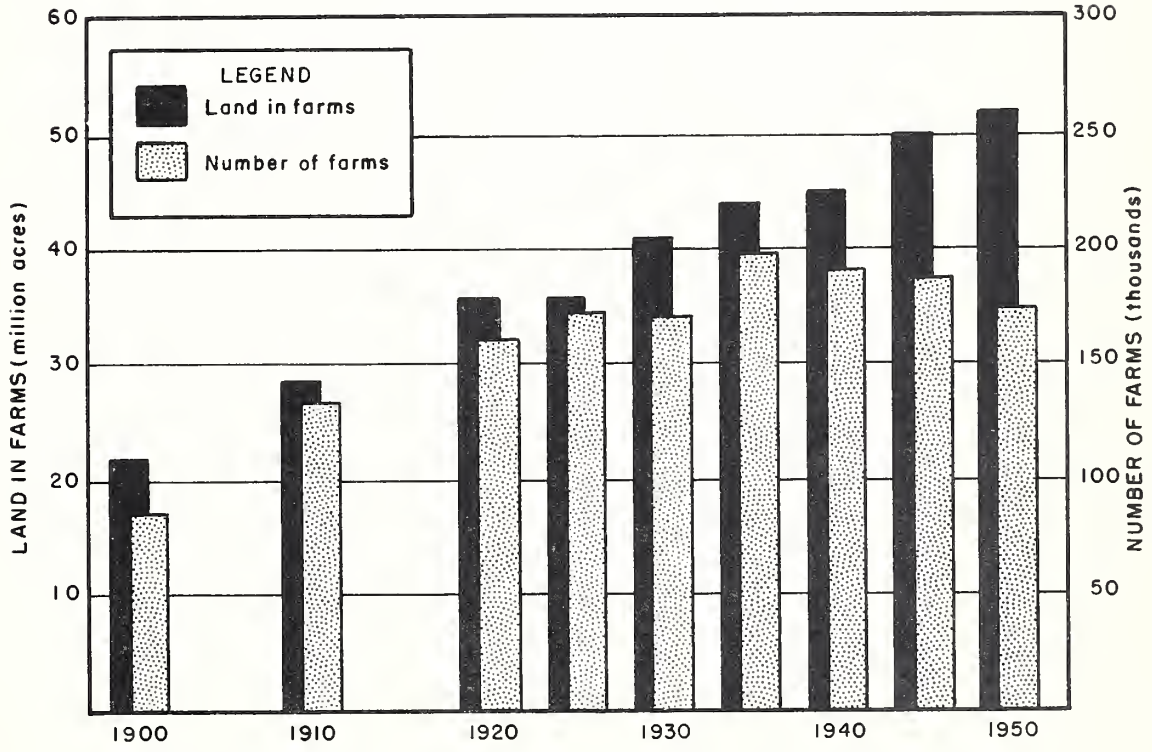
There is a wide variation in farm land use. In many areas only a relatively small proportion of the land in farms is available for cropping. Only in the Big Bend-Palouse wheat area and the Willamette Valley is as much as 50 percent of the farm land available for cropping. Pasture land of all types is of major importance.

In the coastal area of Oregon more than 50 percent of the land in farms is in forest. Farm forest land is of somewhat less importance in the coastal areas of Washington and in the Upper Columbia area.

More than 100 thousand farms are classified as to type. Dairy farms and general field crop farms (primarily wheat) are of equal



Number of farms and average size, Columbia River Basin Area. 1900-1950



Number of farms and all land in farms, Columbia River Basin. Area 1900-1950

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Figure 12

importance as far as numbers are concerned. Each of these types includes approximately one-fourth of all classified farms. Range livestock farms account for 17 percent, general farms 16 percent, fruit and nut farms 10 percent, poultry farms 8 percent, and vegetable farms 3 percent. The unclassified farms are predominantly part-time farms or rural residences.

A wide diversity in soils, climate, topography, and crops makes it possible to produce a large variety of crops in many parts of the Basin. The Willamette Valley is an outstanding example of this. There are, however, concentrations of certain types of farming; for example, about one-third of the dairy farms are located in western Washington and two-fifths of the fruit and nut farms are in the Yakima-Okanogan area.

More than 100 different crops and livestock products are produced commercially, and the importance of any one varies considerably from area to area. Some specialty crops such as mint and hops are of major importance in certain areas. Again, even though of relatively minor importance to the Columbia River Basin, national production of certain crops such as filberts and hops is concentrated largely in this Basin.

In this report relative importance is shown only in terms of amount of land from which the crop is harvested. Wheat is the most important farm crop. Wheat was harvested from 46 percent of the cropland harvested in 1949, and 44 percent of this acreage was in the Big Bend-Palouse area. Hay was harvested from about 25 percent. Wheat, hay, barley, oats, grass seeds, dry field peas, truck crops, potatoes, dry edible beans and sugar beets accounted for 93 percent of the crops harvested in 1949.

The production of livestock through utilization of the forage on range lands is an important part of the agricultural enterprise of the Basin. In 1949 crops were harvested from 11 million acres of land, but it is estimated that 64.3 million acres of open range lands were in grazing use. An additional large acreage of forested land is also grazed by livestock.

There were 3,021,000 head of cattle and calves in the Columbia River Basin on April 1, 1950. Of these, 22 percent were milk cows. There were also 2,764,000 sheep and lambs reported. Less than a half million hogs were reported on farms in 1950.

In addition, 8,143,000 chickens 4 months and older were on farms on April 1, 1950. In 1949, 2.9 million turkeys were raised. More than three-fifths of these turkeys were raised in Oregon with production concentrated largely in the Willamette Valley.

The value of all farm products sold in 1949 amounted to more than 943 million dollars with 55 percent of the value coming from crops, 44 percent from livestock and livestock products, and only 1 percent from farm woodlots.

Of the 173 thousand farms, 108 thousand or 62 percent were considered as commercial farms. The relative importance of commercial farms is presented in Table 10.

Many farm products are produced in quantities greatly in excess of the area's present needs. Markets for these products must be found elsewhere either for the goods in fresh state or in some processed form. A large quantity of farm products is now processed in the Basin.

Table 10.--Comparison of Commercial Farms With Other Farms Columbia River Basin Area, 1949

Item	Total in Basin	in commercial farms	in other farms
		percent	percent
Number of farms	173,000	62	38
Number of farms under 10 acres in size	28,500	25	75
Land in farms - acres	52,200,000	92	8
Cropland harvested - acres	11,100,000	96	4
Value of all farm products sold - dollars	943,200,000	98	2
Value of livestock sold alive - dollars	215,000,000	97	3
Value of dairy products sold - dollars	118,400,000	96	4
Value of poultry or poultry products sold - dollars	66,000,000	95	5

In the three Pacific Northwest states, there were more than 1,500 establishments in 1947 concerned with the processing of food and kindred products. These establishments employed almost 50,000 persons. The processing done by these plants added 300 million dollars to the value of the product.

Forest Resources

Timber-cutting operations began about a century ago with the first settlement of the Basin. The lumbering industry has since been prominent in the economy. Though the past timber harvest has covered more than half of the 66 million acres of commercial forest land, there remains a sawtimber volume of 730 billion board feet of timber within the Basin. This sawtimber volume is more than 40 percent of the total for the United States though the commercial forest area in the Basin is only 14 percent of the United States total.

Table 11.--Volume of Commercial Timber by Type of Ownership
Columbia River Basin Area, 1945

Type of ownership	Saw timber	All commercial timber
	billion board feet1/	billion cubic feet
National forest	330.5	75.7
Indian	22.3	5.1
Other federal	58.2	13.3
State	40.9	9.3
County and municipal	9.6	2.2
Private	269.0	62.1
Total	730.5	167.7

1/ International 1/4 inch - Rule

Virgin timber is now located largely in less accessible areas, and more and more of the readily accessible second-growth is being cut. Average annual sawtimber production is now about 15 billion board feet and other timber uses account for an additional 174 million cubic feet. The value of primary forest products was estimated at $829 million in 1951; this includes all sawlogs, veneer logs, pulp logs, piling, and poles and other minor products.

All but a fraction of one percent of the timber harvested is from coniferous species. Douglas fir contributes about 58 percent of the total volume, the spruce, fir and hemlock types about 19 percent, and ponderosa pine about 14 percent. Added to the timber harvest is the drain on the forest caused by losses from fire, insects, and disease. This drain is estimated at nearly two billion board feet each year. In terms of sawtimber the total drain is

about three times the 5.5 billion net growth in terms of sawtimber, and a little less than twice the net growth in terms of cubic foot volume of all timber.

The most significant aspect of the drain-growth ratio is the marked difference in quality between the relatively high-grade volume being harvested and the presently low-grade volume in the growing stock. This disparity in quality has already seriously affected the forest economy of some areas and will undoubtedly affect the whole pattern of forest management and utilization in the Basin in the future.

The present timber harvest may not exceed allowable cut in many areas because of increasing utilization and increasing growth rates as stagnated overmature stands are removed. However, there is Basin-wide a proportional overcutting of high quality trees and favored species. The supply of high quality, large size, old-growth Douglas fir now commanding a premium market in the plywood industry will be virtually exhausted within 30 years at the present rate of cutting. In the interior and eastern parts of the Basin, half of the total lumber production is ponderosa pine and western white pine; but those species make up only a third of the inventory.

About three-fourths of the timber cut is taken from old-growth stands for the Basin as a whole. Ninety percent of the cut from both old and young stands is classed as sawtimber, and the remaining ten percent as fuel, poles and piling, pulpwood, and fenceposts. The sawtimber includes logs used for plywood manufacture and paper pulp as well as for lumber. Western hemlock and true fir logs go primarily into paper pulp, while Douglas fir goes into lumber and veneer, and ponderosa pine into lumber. Eighty percent of the log

production comes from privately owned lands, and most of the remainder from Federal lands. Farm woodlots over the Basin now contribute over 10 million dollars' worth of forest products annually, a small though significant part of the total timber values produced.

Sustained yield capacity of the commercial forest land in the Columbia River Basin has been estimated at 14 billion board feet of sawtimber (International 1/4 inch - Rule) annually. A little more than 40 percent would come from private forest lands. Most of the production would be logs, about ten percent of which would go to paper pulp manufacture. Though small at present, the production of pulpwood bolts is steadily increasing.

Over 60,000 people are employed in logging, and an additional 140,000 in primary timber manufacture in the Basin. Most of this labor force is concentrated in Oregon, Washington, and northern Idaho. Value added by manufacture is more than one billion dollars. Principal products include rough and finished lumber of all kinds, pulp for paper and rayon, plywood, fibreboard, box shook, and shingles. While future demand for labor in the sawmills may decrease as the high quality old-growth timber is depleted, employment in pulp and paper-board and wood-chemical plants should increase.

Other Resources

Wildlife

The fish and wildlife of the Columbia River Basin are important both from the recreational standpoint and that of the value of the food and fur they produce.

The many perennial streams once provided ideal habitats for salmon and trout. Sedimentation and pollution have destroyed or seriously damaged the habitat in several streams, but the Basin still

remains as one of the better fishing areas of the nation. Water covers 1.8 million acres and provides sport for more than a million fishermen each year. State fish and game departments raise and plant millions of trout and other fish to help meet the demand. The commercial salmon fishery annually takes about 30 million pounds of fish spawned in the Columbia River system.

Streams, lakes, and forested mountains offer a favorable habitat for numerous furbearers. Beaver, fisher, marten, mink, muskrat, otter, skunk, and weasel are found throughout the Basin. The fur hunters and traders were the first white visitors to the area. Trapping furbearers still provides an income of about one million dollars annually over the Basin, although a few of the most desirable animals have become scarce.

Big game populations include over a million deer, about 180,000 elk, 25,000 antelope, 3,000 bighorn sheep, 14,000 mountain goats, 5,000 moose, and more than 50,000 bear. The deer are of three species: mule, blacktail, and whitetail. In recent years, nearly 600,000 hunters take to the field every fall in search of big game.

Uplands birds available to sportsmen include the introduced quail, Chinese pheasant and Hungarian chukar partridge, and the native grouse, prairie chickens, doves, and pigeons. The introduced birds are increasing in numbers, while the native species are declining. Songbirds are everywhere abundant. Small game such as rabbits, squirrels, and raccoon occur in the Basin, and provide sport to young hunters.

Millions of migratory waterfowl and shorebirds depend on the larger lakes and streams for food, shelter, and nesting sites.

Established refuges cover 270,000 acres. More than 360,000 hunters each year are in the field hunting the migratory and upland birds and small game.

Predator populations are low over most of the area. Mountain lion and lynx are scattered through the forested area, while coyotes and bobcats are common to parts of the Basin. Cooperative control programs by the states and the Fish and Wildlife Service have helped to keep their numbers down. Mice, rats, gophers, ground squirrels, and rabbits sometimes affect crop production and range forage, and some control measures are necessary in many areas where natural predators do not keep their numbers low. Porcupines are increasing within the forests, and do considerable damage to the growing timber in some areas.

Recreation

Recreation is a significant and rapidly growing use of the wild lands. Nearly eleven million recreational visits are made each year to national forest areas, and more than four million to the national parks and monuments. State parks also draw more than nine million people each year. This use is constantly expanding, and increases the problems and costs of protection and management. More and more facilities are needed to meet recreation demands. Many communities are largely dependent upon income from tourists, campers, hunters, fishermen, and winter sports enthusiasts. On the national forests alone, there are 1,500 camp and picnic areas, about 80 winter sports areas, about 150 organization camps, nearly 500 hotels, and 5,400 recreation residences.

The total income from recreational use of the basin wild lands, largely concentrated along streams and lakeshores, is estimated to

amount to several hundred million dollars annually. For example, expenditures by out-of-state tourists in Washington are estimated at about $120 million each year, of which some $5 million is paid in the form of sales taxes, gasoline taxes, and city admission taxes. Aside from the monetary aspects, this recreational use is significant in providing opportunity for rest, aesthetic enjoyment, and inspiration to the local population and to many outsiders. Recreational use is desirable as an aid to social and individual health and enjoyment, and will continue to grow as the Basin population grows.

Minerals and Mining

The full extent of the mineral resources is not known, but certain localities have been thoroughly mapped. On the basis of the geologic structure, it is certain that only a few of the great subsurface deposits have been discovered.

Production of copper, zinc, silver, lead, and gold in northern Idaho and western Montana averages about 110 million dollars annually. In central Washington, nearly a million tons of good quality bituminous coal are produced annually. The tremendous phosphate reserves of southern Idaho are just beginning to be developed. Pumice is mined for building block material in central Oregon and central Washington. Other minerals are mined in various locations scattered over the Basin.

Three-fourths of the mining employment is in northern Idaho and western Montana. Over-all employment in this industry is about 60,000. Refining of minerals is done at plants in western Washington, western Oregon, northern Idaho, and western Montana. Alumina is shipped into the basin for processing at several aluminum plants; and

various minerals are shipped out of the Basin for processing elsewhere. Numerous by-products such as sulphuric acid, explosives, and fertilizers are derived from the refining processes.

Transportation and Commerce

The Basin as a whole is dependent upon a well developed and maintained transportation system for the efficient marketing of products. Air, land, and water transportation have a high level of development. Five major transcontinental railroads serve the Basin. In general, the road system is adequate for the farming areas although constant modernization and improvements are required. In farm areas now undergoing development, local road systems frequently are not adequate. Forest access roads are also inadequate for proper management and utilization of forest resources. The river systems are important in the movement of logs and various agricultural products. Ocean going vessels move inland as far as Portland.

For the entire Basin almost one-half of the farm operators live less than five miles from the normal trading center which is usually their marketing center too, with almost one-fourth 10 miles or more from the normal trading center. Distances from trading center are the greatest in the grain and range livestock areas.

Condition and types of roads farmers must use in getting their products to market can have a significant effect on the condition of the products when they reach the market. Rough roads can cause considerable bruising, unnecessary delays, or other damages. More than 40 percent of the farmers have immediate access to hard surface roads, 43 percent to gravel or other improved roads, and 16 percent to only dirt or unimproved roads. However, in traveling to trading centers one-fifth of the farmers must travel between one and five miles on

dirt or unimproved roads, while six percent must travel five or more miles on this type of road.

The maintenance of adequate trade channels is essential to the entire economy of the Columbia River Basin. On April 1, 1950, more than 489 thousand persons were employed in transportation, communications, public utilities, wholesale trade, and retail trade. It is not possible to determine what proportion of these served only the agricultural and forestry industries although most of these served agriculture and forestry at least indirectly. Included in this number were 149 thousand employed in transportation, communications, and utilities. More than 64 thousand were in the wholesale trade, and 275 thousand were in the retail trade. Many persons in these trades handle agricultural or forestry products. The services they supply range from transportation or storage of the raw products to sale of the consumer product at the retail level.

AGRICULTURAL PROGRAM NEEDS

The Columbia River Basin, as has already been pointed out, includes great variations in climate, physiography, geology, soils, settlement and crop adaptations. The problems of conservation, development and use of the agricultural resources are complex, and the program needed to solve them must vary widely from area to area.

The area west of the Cascade Range is characterized by cropland problems involving floods and sedimentation, soil nutrient deficiences, restricted drainage, weed and insect infestation, and soil acidity. Problems are accentuated by pressure of a rapidly increasing population and growing markets.

The forests are predominantly of the Douglas-fir type. Important forest problems include lack of access to over-mature stands, fire and insects, imperfect forest regeneration, inefficient utilization, and premature cutting. Dry summers create special problems for forest as well as cropland.

The area east of the Cascade Range has a drier climate than that to the west and is characterized by wider variations in climate, soils and agriculture. Irrigation is practiced in all provinces, but the four million acres under irrigation include small isolated ranches deep in mountain valleys, small groups and communities along minor water courses, and vast areas of a half million acres or more such as the Snake River Valley. Irrigation will further expand from development of individual small tracts to large projects such as the Columbia Basin Irrigation Project in central Washington. Irrigated crops include those involving both intense culture, as for truck crops and hops, and extensive culture as for domestic hay. Nearly all irrigated areas have complex drainage, irrigation and plant nutrient problems.

Cereal grain culture is practiced in all parts of the Basin. Cropping patterns vary from summer fallow to annual cropping.

Extensive livestock and big game ranges are found among the high mountain slopes, mountain valleys, foothills, plateaus and desert plains. Season of use varies with elevation and with forage type. Variations in condition, cover and precipitation are extreme.

Wide variation in forest condition and type occurs. Major types include ponderosa pine, spruce, fir and hemlock, lodgepole pine, and western white pine. Fire and insect hazards are severe. Problems exist in access, utilization, marketing, protection and reforestation.

The large rivers and their principal tributaries have tremendous flows of water; much of it is unharnessed and flows into the sea. Most of the small tributaries lack flood and irrigation storage facilities and are characterized by rapid runoff in late winter or spring and by low flows during the growing season. Problems affecting development of adequate facilities for flood and irrigation storage include lack of basic hydrologic data, financing, local organization, and economics. General information relating to ground water indicates great reserves may be awaiting development, but adequate basic investigation of specific areas has only begun.

Cropland

The Columbia River Basin includes about 18.5 million acres of cropland of which approximately 4.1 million acres are irrigated. Another million acres will be irrigated by Federal projects now under construction and an additional three million acres have been estimated as potentially irrigable.

The highly diverse conditions greatly complicate its cropland problems. Rainfall varies from 7 inches in the arid parts of the Columbia Plateau to 100 inches along the coastal section. Growing seasons vary from less than 100 days per year in parts of the interior to more than 240 days in the

valleys west of the Cascade Range. Crops range from such specialty crops as cranberries, mint and bulbs to large acreages of wheat, fruit, hops, potatoes, sugar beets, and various seed crops. Large acreages are devoted to livestock and dairy farming.

Problems in Non-Irrigated Areas

West of the Cascade Range the annual precipitation is sufficient to grow a variety of crops without irrigation. The predominantly non-irrigated diversified farms in the Willamette-Cowlitz-Puget lowlands, the flat lands adjacent to the lower Columbia, and the small valleys on the coastal streams comprise practically all of the crop lands in this area. Supplemental irrigation is now practiced, and there will be considerable increase where irrigation water can be made available economically.

In the lowlands west of the Cascades the principal enterprises are dairy, poultry, specialty crops and general farming. The valleys in the coastal area are used largely for specialized dairy farming.

A major problem in this area west of the Cascades is that of poor drainage. Production could be increased materially through improved drainage on about a million acres. There is a large acreage, principally in western Oregon and western Washington, which requires diking for protection against high tides or high river stages.

As precipitation is heavy in the winter and inadequate during the growing season, there is also a need for conservation measures that minimize surface runoff and erosion and conserve moisture for crop production during the summer. Other problems are created by localized floods, streambank erosion, and excessive leaching of plant nutrients.

On the Columbia Plateau an important limitation on agricultural

production is the low annual precipitation. One of the primary problems is a shortage of available moisture. In addition to measures that will conserve moisture, there is need for practices to prevent wind erosion on the light soils, to restore organic matter and plant nutrients and to prevent water erosion on the slopes. This area is used primarily for the production of cereal grains with the land maintained in fallow in alternate years to accumulate nitrogen and conserve moisture. About a half million acres were under irrigation in 1952 and a total of about a million acres will be eventually irrigated by the Columbia Basin Irrigation Project.

In the Upper Snake River Plains low precipitation and a short growing season combine to limit production. The problems are similar to those on the Columbia Plateau with the primary need for practices that conserve moisture. The non-irrigated farms in this area are used for wheat and general farming. The irrigated portions are used mainly for the production of alfalfa, potatoes, dry beans, sugar beets, and livestock.

The Palouse and Blue Mountain foothills comprise a famous wheat producing area. There is sufficient rainfall to produce an annual crop. Peas are frequently alternated with wheat in a rotation. The steepness of the land, susceptibility of soil to erosion and heavy winter season precipitation result in severe soil losses. This, in turn, has given rise to serious sedimentation problems. There is an urgent need for land use adjustments and conservation measures that will prevent water erosion and at the same time conserve moisture.

In the narrow river valleys of northeastern Washington, northern Idaho and western Montana problems are created by the short growing season, localized flooding, inadequate farm and community drainage,

water erosion on steep slopes, severe infestations of noxious weeds, and inadequate amounts of precipitation during the growing season. These areas are used largely for dairy and livestock enterprises. The irrigated portions of these lands are used for production of livestock feed and special crops.

Problems in Irrigated Areas

Approximately 4.1 million acres in the Basin are irrigated by large Federal irrigation projects, by projects developed by private enterprise, by simple community diversions of water from streams, or by development of wells.

The irrigated valleys of the east slope of the Cascade Mountains in Washington are used for fruit, livestock and mixed farming. In the Snake River Valley in eastern Oregon and western Idaho, hay and sugar beet production and dairying are the dominant farm enterprises. In the irrigated valleys of the Upper Snake livestock production and potatoes, dry beans, alfalfa and sugar beets predominate. General farming and livestock production are the primary enterprises in western Montana.

Moderate to critical deterioration has taken place on most of the irrigated lands of the Basin. Considerable areas of land have been water logged by the application of excessive quantities of water or by seepage from higher irrigated lands and canals. In many areas saline or alkali accumulations are limiting production.

On newly irrigated lands, settlers need technical assistance in land preparation, in laying out farm irrigation systems, in planning cropping systems and in applying other conservation practices.

In many areas supplemental water supplies for irrigation are needed. This is particularly true in the tributary stream valleys where the present water supply is limited to the natural flow and is inadequate for supplying

the moisture requirement of crops for the full growing season.

Irrigation practices need to be improved to maintain fertility, prevent water logging, reduce erosion and conserve irrigation water.

Drainage Problems

The problem of inadequate drainage is important in the Columbia River Basin. Productivity could be improved on more than 2 million acres if better drainage were provided.

The drainage problems west of the Cascades are due to the combined effect of the normal precipitation and characteristics of soils and topography that impede natural drainage. The wet soils generally are heavy textured and often acid in reaction and they absorb and transmit water slowly. The existing natural drainage patterns frequently do not provide adequate channels to carry off the accumulations of heavy winter precipitation.

In the arid and semi-arid areas the drainage problems are caused by irrigation development. The natural surface and subsurface drainage patterns of many of these areas are adequate for the orderly disposal of the normal low precipitation, but they will not permit the timely removal of excess irrigation water.

Irrigation of bench lands frequently causes water to percolate into the subsoil of lower-lying lands. Excessive seepage from canals and ditches also contributes to the water-logging of bottom lands. The application of more irrigation water than is needed often is responsible for raising the water tables to levels that reduce crop production.

Drainage improvements are more urgently needed in the irrigated areas than in the humid areas. In the humid areas the poor drainage conditions restrict the use of the land and make it less productive, but the land is not permanently damaged. These lands can be drained and their full potential

realized. A large part of the land needing drainage improvement in the irrigated areas is subject to increasing soil deterioration from salt and alkali accumulations. Evaporation leaves ever increasing concentrations of salt or alkali in the soils. Improved drainage would permit the leaching out and removal of a large part of these concentrations.

Cropland Program Objectives and Scope

The objective of the cropland program is to use each acre within its physical and economic capabilities and to treat each acre in accordance with its needs for protection and improvement. The application of the measures and practices described will insure the conservation of the soil resources and will also result in greater sustained production of food and fiber.

Erosion and declining soil fertility can be combated by using such practices as crop rotations, protective seedings, fertilizers and soil amendments. Additional measures such as construction of terraces, diversion ditches, and contour strip cropping prevent runoff water from concentrating into damaging flows. The solution to the problem of soil deterioration varies considerably with the physical quality of the land, the crops grown and climatic conditions. Farmers generally are making good progress in applying needed conservation measures to the land. Some measures are being widely applied, while others are in only limited use. The acreages of various measures needed, as shown in the following pages, represent the amounts needed beyond those being presently applied.

Practices Principally for Soil Protection

Contour farming is working slopes in such a manner that plowing, planting, cultivating and harvesting operations in the production of field crops and in orchards and vineyards follow lines that are level or conform

to accepted standards for grades. This practice increases moisture penetration and helps control water erosion. It is frequently used in conjunction with terraces, field diversions, contour strip cropping, or contour planted tree or vine rows which provide permanent guide lines. All sloping lands with water erosion as a problem should be farmed on the contour. Cross-slope farming may be substituted in areas of broken topography where contour farming is impractical. A total of seven million additional acres of cropland should be farmed on the contour. This includes contour strip cropping and contour planting.

Contour strip cropping is the growing of field crops alternating with close growing crops or fallow in strips or bands parallel to surveyed contour or grade lines. Contour strip cropping is most applicable to wheat land in the higher and intermediate precipitation zones that has long and rather gentle slopes. This practice is needed on about 3.5 million acres.

Contour planting of orchards, vineyards, cane fruits and other perennial rooted crops consists of laying out the crop rows so that they are level or on standard grades. This practice is required on irrigated land with slopes of such gradient or with soil of such texture that irrigation water will cause serious erosion if allowed to run on the full grade of the slope. Contour planting of irrigated orchards is particularly needed along the Columbia River Gorge, in the Yakima-Wenatchee-Okanogan Area, and in parts of western Idaho. Contour planting is also desirable on non-irrigated land in areas where rainfall and runoff are high. It is especially adaptable to sloping hill and on terrace land west of the Cascades in Oregon and Washington. Contour plantings should be made on approximately 106 thousand acres.

Terraces are graded channels running across a slope at systematic intervals to intercept and control runoff and minimize erosion. The

channels are constructed with supporting ridges on the lower sides and are laid out so they can be cultivated with the field. They are most applicable to wheat lands in the Blue Mountain foothill area of Washington and Oregon and in north central Oregon. Terraces are difficult to use where the topography is irregular and the slopes steep, and are generally not recommended in areas of heavy snowfall because of channel plugging by snowdrift and ice. About 6,900 additional miles of terraces are needed.

Field diversions are graded channels across the slope installed individually or in a series to intercept runoff, minimize erosion or prevent excess runoff onto lower-lying areas. The channels are constructed with supporting ridges on the lower sides. They are not cultivated with the field and usually are protected by vegetation. This practice is appropriate where runoff is a problem on sloping croplands. Areas in the Basin where this practice is applicable include lands on the eastern edge of the Washington wheat belt nearest the mountains; some lands in south central Washington; the narrow mountain valleys in Idaho; the eastern edge of the wheat belt in southern Idaho and near the mountains in northern Idaho; and the southern edge of the wheat belt near the Blue Mountains and in some of the mountain valleys in Oregon. Field diversions are recommended in conjunction with contour strip cropping on moderately sloping land and with hill top and pasture seedings on steep land. About 17,000 additional miles of field diversions are needed.

Wind strip cropping is the growing of field crops in alternate bands in combinations of sod crops or close-grown crops with row crops or fallow crosswise to the prevailing winds. This practice is used primarily for wind erosion control. It provides greatest benefits under a rotation system of crop production with part of the land in grass and legumes. Wind strip cropping is needed on about 1,344,000 acres.

Practices Principally for Soil Improvement

Crop residue utilization is the use of vegetative materials such as grain stubble, or other residues on croplands in such a manner as to conserve moisture, increase organic matter and reduce wind and water erosion. This practice includes mixing the materials in the soil or leaving them wholly or partially on the surface. The utilization of straw and stubble or other crop residues as a surface mulch helps to control wind and water erosion during the periods when the land would otherwise be bare and unprotected. On most irrigated farms where row crops follow grain or corn, the stalks and stubble should be incorporated with the soil so that the surface will be free of trash for best seed bed preparation. A surface mulch for strawberries, commercial vegetables and other row crops is sometimes provided by hauling on straw, hay, pea vines, sawdust or any other suitable vegetative material. The important consideration is that all crop residues be returned to the soil and not be burned. The practice of crop residue utilization should be applied to all cropland.

Other special tillage operations to conserve moisture and control erosion include chiseling, rotary subsoiling or chiseling and emergency furrowing. Emergency furrowing is frequently desirable in sandy soil areas where wind erosion is a problem. Furrows are plowed across the direction of the prevailing wind to serve as temporary barriers to sand drifting. Chiseling to break up hardpan layers or compact lime subsoils helps to increase moisture penetration in the semiarid zones on both nonirrigated and irrigated soils. Rotary subsoiling or chiseling are desirable on many farms where fields are to lie fallow or under stubble during the winter months. This practice helps to prevent the formation of impervious frost layers and allow greatest winter water infiltration. Tillage operations of these types are required on about 3,009,000 additional acres.

Green manure and cover crops to improve and protect the soil are very important in the maintenance of croplands. These are grown primarily to supply organic matter and nitrogen, but do provide protection against erosion until they are turned under. Green manure crops incorporated into the soil improve the soil structure fertility. There is need for these practices on 3,243,000 acres with 737,000 acres to be applied annually.

Rotation seedings are the seeding of perennial grasses and legumes in a crop rotation. The purpose is to grow soil-improving crops in the rotation to offset the effects of the soil-depleting crops. Most row crops and grain crops are usually classified as soil-depleting; grasses and legumes as soil-improving crops. Lands that are badly eroded or have steep slopes should be in soil-improving crops most of the time. More fertile, less steep lands with deeper soils can be maintained in permanent productivity with less frequent use of soil-improving crops in the rotation. It is estimated that this practice should be established on 6,992,000 acres with annual seedings of about 967,000 acres.

Liming is the practice of applying lime to crop and pasture land to: correct soil acidity; to supply calcium for plant growth; to improve the physical texture of the soil; to improve the chemical and biological activity; and to improve the competitive powers of desirable species of plants. A total of about 2,785,000 acres needs periodic applications of lime with about 368,000 acres being treated each year.

Fertilizing is the adding of any material to the soil to supply one or more of the essential plant nutrients. The specific fertilizers needed vary considerably for different lands. The acid soils of the humid areas require applications of nitrogen, phosphorus and in many cases potassium, sulfur and boron to establish soil-improving crops

and to increase production of other crops. The more arid areas require nitrogen and phosphorus for the continued successful production of cereal grain crops, hays and pastures. Applications of amendments containing sulfur are required for soil improving green manure and hay crops. Boron is frequently required for legume production in areas of higher rainfall and for orchards, vineyards, nuts and other speciality crops. Phosphorus fertilization is generally required for high crop yields on soils which have been farmed for 15 years or more.

The need for supplementary applications of various types and kinds of fertilizers will become more acute as cropping practices become more intensive and with additional years of crop drain on the soil fertility. Fertilizer applications are needed on about 6,483,000 acres annually to increase production of crops and pasture; and on about 2,544,000 acres at an annual rate of 410,000 acres to establish and promote growth of soil-improving crops.

Practices Applicable to Pastures

Pasture seeding is seeding of land to grasses and legumes where the primary use of the land is for pasture. The land is farmed to other crops only frequently enough to control weeds. Occasionally it is re-seeded to maintain desirable grasses and legumes. This practice is particularly applicable in western Oregon and Washington and in the irrigated areas east of the Cascades. Approximately 1,534,000 acres that are in pasture or for which the best use is pasture should be seeded at the proper intervals to maintain the more desirable plants. This would require that about 177,000 acres be seeded each year.

Pasture management includes the orderly scheduling of practices to keep pastures producing high quality of forage over a long period. It involves such practices as deferred and rotation grazing, proper stocking,

mowing to control weeds, fertilizing, liming, seeding, scattering droppings, contour furrowing, or other methods to increase and improve the vegetation for grazing purposes. Improved pasture management is needed on most of the pastures in the Basin. It is estimated that about 2,974,000 acres of pasture could be improved by better management.

Improving Irrigation Practices

The Columbia River Basin is popularly considered to contain abundant water resources, yet severe irrigation water shortages occur frequently in some localities. The benefits of irrigation could be extended to additional lands if more efficient use were made of existing water supplies.

While there are variations between projects, and between farms, an estimated average of but one-fourth to one-third of the water diverted into main supply canals is used by crops grown on farms supplied by those canals. Nearly one-half of the diverted water is lost by seepage in the canals and ditches conducting it from the point of diversion to the farm. About half of the water actually delivered to the farms is lost by surface runoff or by deep percolation below the crop root zones as a result of inadequate distribution systems or by improper water application practices, or both. Improper application of irrigation water causes serious damage to the land through erosion, water-logging or accumulation of alkali salts in the root zone.

Proper preparation of land for irrigation is necessary for efficient water and land management. It is necessary first to determine the irrigation method most appropriate to the topography and characteristics of the soil to be irrigated. If surface irrigation is to be used, the land must be leveled to permit efficient irrigation with a minimum amount of

labor. If sprinkler irrigation is used, requirements for land preparation are greatly reduced.

Clearing, leveling, floating and other surface treatment is required on about 3,040,000 acres of land to permit efficient application of irrigation water. This includes about a million acres of new land being irrigated or to be irrigated by projects now under construction.

Improving water application is partly a matter of education. A large part of the water that is wasted and the damage that is done by over irrigation can be attributed to the irrigator's lack of understanding of the relation between the stream of water, the soil moisture reservoir in the crop root zone, and the damages resulting from over-irrigation. Irrigation practices should be improved on about four million acres of the land now being irrigated.

Improving and Developing Irrigation Systems

Improving farm irrigation systems is an important measure for increasing water application efficiency and conserving soil. On many farms the irrigation runs are too long to get reasonably uniform application of water, irrigation grades are too steep to avoid excessive erosion, or the system used is not appropriate for the characteristics of soil and topography or the crops grown.

There has been rapid development since 1940 in understanding good farm irrigation system layout as prompted by the soil, the water supply, and the method of irrigation. Heavy earth moving equipment permits lands to be leveled more economically. These advances have found rapid acceptance and many farm irrigation systems are being revised. A more uniform application of irrigation water is being obtained by leveling lands and relocating ditches to allow more desirable lengths of run. Control

structures are being installed to decrease ditch erosion and to facilitate handling of the water. Sprinkler systems are being installed on land where the characteristics of soils and topography make this method the most practical. Even so, additional improvements of these types are needed on about 2,584,000 acres of irrigated land.

Improving trunk line systems is an effective way to increase the irrigation water supply by reducing transportation losses. Many canals and laterals require relocation or rehabilitation. Seepage losses in these trunk line systems frequently far exceed the amounts of water delivered to the land to be irrigated. Such seepage losses are frequently primary causes of severe drainage problems existing or developing on irrigation projects. Trunk line systems needing improvement affect an area of about 1,105,000 acres.

Developing irrigation facilities to provide water for new lands and to supplement supplies for some of the older irrigation developments will permit more intensive use of large areas of land. Flood waters and other surface runoff not now used can be stored in reservoirs. Canals and diversion and control structures will be required to distribute these waters. One of the potential sources for irrigation water is ground water which can be had by developing springs and wells and by developing artesian flows. Small flows may be utilized more effectively by storing them in small reservoirs for a short period making a larger flow available for a more efficient and shorter period of use. Further, waters wasted from irrigation projects frequently can be intercepted or pumped to provide dependable supplies on other lands.

Farm irrigation systems for distributing water on lands to be brought under irrigation are important to the rapid expansion of irrigation. These

systems should be designed with due regard for the characteristics of the available water supply, the topography, the soils and the crops to be grown. They should be planned to permit appropriate land preparation before the farm development restricts design.

It is estimated that about 61,500 new farm irrigation systems will be required on the additional lands that may be brought under irrigation.

Practices to Improve Drainage

The humid parts of the basin area contain about half the acreage which needs improved drainage. In the Willamette Valley, for example, it is estimated that production could be increased appreciably through improved drainage on approximately 600,000 acres, about 90 percent of which requires subsurface drainage. The Oregon coastal valleys contain about 100,000 acres of cropland and the coastal and Puget Sound valleys of western Washington about 300,000 acres which would be benefited significantly by improved drainage. In northeastern Washington and northern Idaho about 50,000 acres of cropland are too wet. There are about 100,000 acres, principally in western Oregon and western Washington which require diking for protection against high tides or high river stages.

Drainage improvements are required to remove excess water from the land to permit early working of the soil in the spring and to maintain favorable moisture conditions for plant growth. They include tile drains, open ditches, beds, dikes and diversions or combinations of these practices.

Drainage problems in areas where irrigation is extensive are, for the most part, subsurface problems concerning large areas rather than individual farm units. Drainage improvements under these circumstances must be of an area type and can be planned effectively only after thorough consideration of natural physiographic units which are often valley-wide

in extent. The necessary measures are of two general types; those designed to intercept surface and subsurface waters at points where they can be carried away without contributing to the damaging high water tables; and those designed to lower existing high water tables.

The first type usually requires large open drainage ditches or closed drains located at appropriate depths in strategic places where incoming waters can be intercepted. The second type requires a system of open ditches or tiles properly spaced with gravity outlet systems or pumping systems to raise the water to the ground surface where it is carried away in surface drainage ditches or used for irrigation.

Drainage improvement measures are needed on about a million acres of land in the irrigated sections of the Basin. The irrigation of additional large acreages of land, as is proposed, will undoubtedly result in additional land requiring drainage improvements.

It is estimated that 13,600 miles of open ditches and pipe lines will be required as community systems to dispose of water accumulated by individual farm drainage systems where natural outlets do not exist.

Miscellaneous Practices

Correcting soil salinity is an urgently needed measure over a considerable area. Salinity as used here refers to excessive accumulation of soluble salts (saline soils), or by excessively high exchangeable sodium (alkali soils) induced by accumulations of sodium salts, or a combination of these two conditions. Alkali soils may also form when irrigation water with a relatively high concentration of salts is used. Corrections of these conditions require good drainage, use of amendments to replace excess exchangeable sodium of alkali soils with calcium, and leaching by flooding to remove excess salt. There are about 445,000 acres of land requiring treatment for correcting soil salinity or alkalinity.

Farm ponds are needed to provide for fire control, stock water and supplemental irrigation. Some ponds are suitable for stocking with fish and provide wildlife habitat. Approximately 14,500 ponds of this type are needed.

Improving wildlife areas for game species on cropland requires consideration of the food, water and protection requirements of the game. Fencing is one of the most important methods of improving wildlife areas. The exclusion of livestock from springs, farm ponds and marshes assures more usable areas for upland game, furbearers, and waterfowl. In addition protected odd areas, field corners, farm ponds, and gullies retard erosion and assure cover and food for pheasants, rabbits, quail and other small game species.

All wildlife areas should be guarded against fire and unwise use of chemical sprays for weed control. Food habit studies show that herbaceous plants and shrubs contribute much of the food for most wildlife species found in agricultural areas. It is estimated that about 2,000,000 acres should be improved for wildlife use.

Cleanup clearing is required on brush and stump lands to permit the most effective use of the land for agricultural purposes. It is estimated that this measure should be applied to about 365,000 acres.

Fire protection for crops and farm plant facilities is a primary requirement for successful management. Little cropland need actually be devoted to fire protection other than fire lanes around grain and pasture lands when the vegetation is easily burned. Permanent tree plantings should be protected by fire lanes whenever necessary.

Protection from fire is primarily a matter of education, in identification of fire hazards, and how to remove them. Group and community action for fire protection can be accomplished by organizing

and equipping rural fire protection cooperatives or districts.

Benefits of the Cropland Program

The cropland program outlined will result in many benefits. For example, improved cultural practices together with proper land use will bring about a material reduction in erosion and runoff. This means reduced damages from floodwater and sedimentation. Crop yields will be increased or at least maintained at their present levels. Increased amounts of food, fats and fiber will be available to help meet the demands for a constantly increasing population. The cropland program is a dynamic program, designed to achieve full economic use of the basin's cropland resources in time of peace or in time of national emergency.

Illustrative of the conservation benefits resulting from the recommended program is the estimated increased production of major crops over those which would prevail without a conservation program. Assuming, for the purpose of illustration, that present cropland acreages would not change, it is estimated that the average annual increase in production of wheat and oats would be about one-fifth of the present production while hay and potatoes would be increased by about one-fourth. While detailed analyses have not been made for all crops, it is believed that other crops also would have substantial yield increases.

Rangeland

Problems relating to rangeland in the Columbia River Basin are many and concern both technical and management aspects of rangeland use. They are important problems involving 123.5 million acres of public and private lands. Rangelands are located in all physiographic provinces of the Basin and are affected by many divergent conditions

brought about by climate, soils, ownership, use, fire and others. Specific problems may be of major importance in one physiographic province, but of less or minor importance in another.

Problems of Multiple Watershed Uses

Multiple use on rangelands is rapidly gaining wide recognition. Many areas are being used for livestock grazing, big game habitats, timber production, water source areas, and recreation sites. Each of these uses may impose different management patterns, frequently conflicting with one another. Such multiple uses are often the primary causes of some of the problems to be mentioned later in this report. Decreased forage production is the basic result of current problems area-wide. A large part of the total range is in unsatisfactory condition, from a standpoint of forage production, soil stability, and water control. The primary causes that are still current and deserve additional attention include: Mixed ownership pattern, inadequate use of existing information and research data, inadequacy of fire control, lack of balance between summer and winter game range, brush invasion, insufficient water supply, inadequate range rotation and rest periods, improper stocking rates, and withdrawal of range areas, reclamation projects, national defense projects and conversion to grain production.

Over 4 million acres of cropland in the Columbia Basin area are dependent on irrigation water produced from watersheds grazed by livestock and big game. Steep watersheds having light or coarse textured soils produce considerable silt and debris and become unstable when clothing vegetation is abused or removed. Such silt and debris are causing heavy damage to canals, reservoirs and other works of man.

About 26 million acres of commercial forest land are grazed. Watershed and timber values in many cases may exceed the range forage value

for livestock. Forage growth and utilization may affect timber regeneration and growth. On both public and private range lands compatibility of timber production and forage production has not been adequately determined. Recreational values are high in some parts of the forested range areas, particularly in the Wallowa Mountains, and the west slope of the Rocky Mountains. Grazing should be excluded from some recreational areas. Greater attention should be given to grazing effects upon fish propagation. In many areas, grazing around small streams is detrimental to fish life through trampling of spawning grounds and stream banks, and elimination of good bank cover.

Mining enterprises, principally placer and dredging, have adversely affected or destroyed substantial areas of high producing meadow and mountain valley range areas and fish streams. Provision for restoration of these areas into high forage producing areas presents a problem involving legislation, economics and education.

Big game consumes 15 to 20 percent of the forage produced on range lands in the Basin. About 30 percent of the forage on the forested rangeland areas is utilized by big game, not all of which is palatable to domestic livestock. The remainder of the forage is used by livestock. On many ranges suitable for fall and winter use all or nearly all of the forage is required for winter use by big game. However, in many areas fall and winter big game ranges are almost depleted of vegetation by livestock prior to the movement of big game from summer habitats to fall and winter grazing areas. During the winter most big game occupy fringe areas at the foot of high mountains and above valley floors as winter survival areas. Encroachment of irrigation farming, dry farming and fenced pastures into the upland areas the past quarter century has

seriously diminished big game fall and winter ranges; game numbers have meanwhile increased.

Some ranch operators and other rangeland users do not yet recognize the quantity of forage that must be made available on both summer and winter ranges if big game are to survive in reasonable numbers. Further attention and study should be made to correlate desirable and practical game numbers consistent with available summer and winter use with respect to the local livestock economy, special hunting seasons, etc. This involves cooperation and understanding between livestock operators, sportsmen's organizations and state and Federal agencies concerned. Supplemental feeding of big game is not an answer to overstocked winter game ranges.

Principal game problem areas exist on the east slopes of the Cascade Range, north central Oregon, western Montana, western Wyoming, and southwestern Idaho.

Ownership Problems

Ownership patterns in several parts of the area conflict with good range use. Checkerboard ownership presents serious problems, particularly in the Snake River Plain, Harney Basin and Ochoco-Blue-Wallowa Mountains provinces. Interspersed private and public lands prevent improvement programs from becoming effective. Fencing cannot be economically accomplished when this pattern exists. Fencing of one ownership precludes stock from adjacent areas using natural watering places. Reseeding developments cannot be successfully carried out unless the seeded area can be protected from livestock and rodents during the establishment period.

A common period of use, preferably the one permitting resource perpetuation in as good or in an improved condition, is difficult because of

divergent interests and forces affecting all private and public interests. An operator, facing short feed reserves in early spring, is anxious to be on the range even when great damage may result from trampling in wet ground.

Landowners generally are making serious efforts toward solution of the intermingled private-public rangeland problem in the interests of range improvement on both kinds of land, but so far relatively little improvement has been made.

Protection and Management Problems

Information accumulated by progressive rangeland operators and local, state and Federal agencies, is being inadequately used. Additional means are needed to establish cooperative efforts to disseminate information and to gain acceptance of proven techniques. Federal agencies and state institutions have developed or introduced many new strains of grasses and legumes, which are better adapted for range improvement. New methods of range improvement through reseeding and management are practical and economically feasible; however, their acceptance has not been widespread.

Inadequate fire control on some private and public ranges results in great loss of annual forage supply, fences, buildings and further deterioration of the physical rangeland conditions. In addition to the loss in forage values many fires result in accelerated erosion that makes range restoration more difficult, and that causes silting of ponds, reservoirs, canals and highways.

Most serious fires on private ranges are caused by carelessness or by intentional burning. On public lands, generally less accessible to the public and at higher elevations, most fires are caused by lightning, although carelessness by campers, fishermen and others also cause numerous fires.

Fire detection and control are least adequate on private rangelands because there are fewer organized detection and control systems. Private ranges, for the most part, lie at lower elevations and have higher temperatures, lower relative humidity, and lower rainfall resulting in longer periods of high inflammability. Annual vegetation, predominantly cheat grass, is highly inflammable throughout the late spring and summer months. Continued poor use and fires on most of these lands have resulted in marked, and in some cases, total loss of perennial vegetation.

Fires on low, dry ranges, whether on private or public lands, are a constant serious threat to higher adjacent rangelands which are often forested. Hot, dry winds often carry low range fires into upland ranges in a very short time and before organized efforts, if any are locally available, can begin to cope with the problem. They have been known to sweep through several ranches and over miles of open rangeland in a matter of minutes, destroying vegetation, fences, buildings, equipment, and adjacent ripening grain fields. Such fires occur frequently on the Snake River Plain.

The prevention of range fires involves problems in public education, development of local organizations to prevent and control fires, development of special equipment, and recognition that properly improved and managed ranges are less subject to fire hazard than are poor, rundown ranges.

Withdrawal of rangelands for other uses has, in many instances, caused further concentration of livestock on other ranges already overused. For the most part, lands converted to crop use have been used for grain production under the wheat-fallow system. Small acreages have been placed under irrigation. In many cases these lands are shallow, rocky or otherwise unsuited for crop production.

During and after both World Wars vast acreages of rangelands were

converted to crop use. Some of these lands were abandoned after being sown to grain several seasons. Sagebrush and other low forage producing and less palatable plants invaded, making redevelopment of the lands for range use uneconomical. Broken down fences in many instances continue for years to be a serious hazard to livestock.

Large acreages withdrawn for national defense installations necessitated increased use of already heavily stocked adjacent ranges. Gradually some of the withdrawn lands are being released for grazing purposes.

Brush invasion and control is another serious range problem. Brush invasion has occurred on millions of acres, principally in the Columbia Plateau, Harney Basin, Snake River Plain, East slopes of the Cascade Range, and West slope of the Rocky Mountains. Invasion of brush has been caused principally by overgrazing and fire. Following forest fires, brush rapidly takes over moist north slopes in mountain areas, to such a degree that little edible forage grass can exist. Brush occupying moist sites in mountainous areas transpires tremendous quantities of water otherwise available for stream flow.

On the plateaus and plains, sagebrush, rabbitbrush and other non-palatable brush species have occupied tremendous areas of private and public range where grass stands have been depleted. Effective and economical spray eradication methods have been only partially developed. Brush eradication by plowing, discing or beating is costly and sometimes but partially effective.

The history of water supply on rangelands is a romantic tale of the early West. It has often been said "who controls the water controls the range." The statement is still true. About half of the Basin comprising southern Idaho, all of Oregon east of the Cascade Mountains and south central and southeastern Washington generally has inadequately

developed water supplies on the ranges. The predominant need for water is on the plains and plateaus. The need exists on both private and public land. Large areas of public land are almost wholly without developed water, so that their use is limited to winter and very early spring. Many ranchers give inadequate consideration to ample stock water needs, and public agencies frequently do not have adequate funds to provide the needed developments. Lack of water in one area usually results in over-use of an adjacent area having adequate water. Many ranch operators recognize the need for additional water for economical, effective range management, but may need financial or other assistance to develop water facilities. Some operators now recognize the value of hauling water for better livestock distribution.

It is important that winter ranges be used only during the dormant season, in order that new seedlings can perpetuate the range. For the most part, winter ranges have been used too late in the spring with consequent damage to young plants.

Spring-fall ranges have been grazed too early in the spring before plants can stand heavy use. Over-utilization in any period reduces plant vigor and seedling establishment. Since the period of succulent growth coincides with the period when heaviest damage can be done by over-use, it is not difficult to understand why spring-fall ranges have become so severely depleted. Summer ranges are generally in somewhat better condition. This is due principally to location, usually high in mountainous areas, short season of use and higher growing season precipitation. Overstocking, regardless of season of use, runs down the range. Results are loss of seed supply, trampling of organic cover and young plants, and increased erosion and runoff. Adequate application of proper management measures requires intensive education, demonstrations and technical assistance.

Rotation and deferred grazing provides alternate rest periods every few years, or in some cases biannually permitting increased seed production and seedling establishment and general improvement in plant vigor. Alternate use of fall or spring periods, and deferment for whole grazing seasons is needed to improve range conditions on the vast majority of the rangeland. Lack of attention to these management practices has resulted in smaller livestock gains, reduced calf and lamb crops, reduced wood production, increased losses from poisonous plants, and higher unit operating costs. Considerable annual variation occurs in forage production, particularly on the spring-fall ranges. Limiting livestock numbers to an average annual carrying capacity has been a long standing problem.

Problems relating to noxious weeds, poisonous plants, rodents and diseases are covered in the section of this report dealing with problems affecting all lands.

Rangeland Program Objectives and Scope

Major objectives of the rangeland program recommended for the Columbia River Basin are: increasing forage production on both forested and non-forested rangelands, and stabilizing land to insure high yields of forage and forest products. The program will be mutually beneficial to livestock interests, wildlife interests, water resource interests and interests of the general public through the conservation and preservation of the natural resource.

To accomplish these objectives the present productive capacity of rangeland in satisfactory condition must be maintained; depleted ranges must be restored to their highest economical productive potential, and satisfactory management practices must be at the same time applied for livestock and big game as well as for other wildlife needs.

To achieve these goals a program of conservation, development and use of the range resource is recommended which involves the following major phases: practices for range improvement to protect the land and its cover and practices for improving management of the range by practices for the control of insects, disease, and rodents; and for technical and educational services to owners and managers of rangeland are outlined in following section.

Practices for Range Improvement

Seeding and planting of grasses, forbs, and shrubs are recommended as a means of restoring vegetation on range-watershed lands now producing far below their potential capacity. These practices will be applied only to lands where vegetation is so badly depleted that natural sources of seed are lacking or where natural revegetation will require an excessively long time, or where successful rehabilitation is reasonably assured. Reseeding is especially urgent in the Blue Mountains of eastern Oregon, in adjacent Washington, and in southern Idaho. Need is greatest for seeding and planting on the low-lying ranges.

Revegetation by reseeding and planting is an important flood and erosion control measure on many foothill and mountain lands where existing cover provides insufficient protection. Needs amount to 11,393,000 acres, of which 4,940,000 acres are public lands.

Removing woody plants unpalatable to both livestock and big game so that desirable herbaceous forage species can be established naturally or by seeding is needed at scattered locations throughout the Basin. The work is especially urgent in the sagebrush zone of southeastern Oregon and southern Idaho. In the Snake River Plains the removal of sagebrush followed by seeding of grasses has increased forage production from 5

to 10 times depending on the condition of the unimproved range. Removal of undesirable brush is needed on about 6,977,000 acres of land. Of this, approximately 10 percent is Federal land and about one-half applies to valley and foothill private rangelands, mostly with sagebrush cover.

Diverting flood runoff from foothill and mountain lands and utilizing it to increase forage production on mountain meadows and low-lying rangelands is needed. Of the 620,000 acres where needed, 18 percent is public land, nearly all of which is Federal.

Fertilizing rangelands is advisable in many areas at the time seeding is done. It is estimated that fertilizers are needed on about 5,591,000 acres, almost all of which is in private ownership.

Fire protection measures consisting of improved detection and organized control systems are required on about 24.3 million acres of private non-forested rangeland.

Practices for Range Management

Fencing is needed for both protection and management. Protective fences are for the purpose of keeping livestock from newly seeded lands for a 2-or 3-year establishment period and of excluding grazing on administrative sites, campgrounds, and other special use tracts. Management fences are needed to regulate use, to control livestock drift, and regulate stock movement in accordance with seasonal readiness of vegetation, and to break pastures and allotments into manageable units. About 5,600 miles of protective fences and 47,800 miles of management fences are needed, of which 30,700 miles are needed on public lands.

Poor balance between livestock numbers and forage production, together with improper seasons of use, are the most serious problems confronting range operators. To correct this situation, range vegetation with temporary exclusion and deferred-rotation grazing are

recommended. Practices aimed at building up and improving the carrying capacity of the range will require other sources of forage be used for a time.

Proper stocking, deferred and rotation grazing are fundamental in perpetuating forage plants. These practices have been highly effective in maintaining healthy range conditions and in the restoring of depleted ranges. Deferred grazing is needed annually on 5,258,000 acres of rangeland.

A more intensive management program for livestock and big game is needed on both the non-forested and forested range covering 81 million acres.

The development of ponds, springs, and wells, and the hauling of water are recommended to provide water for livestock. On the spring-fall ranges, especially those in southern Idaho and southeastern Oregon, and on many summer ranges, the number and distribution of stock watering places are inadequate, and livestock distribution is not uniform. The program will lighten the heavy use near existing water and will make much presently unused forage accessible, thereby improving livestock distribution. Stock watering facilities are needed on lands of all ownerships, but the need is by far the greatest on the low-lying semi-arid ranges. The needed program includes development of 31,600 ponds, 8,300 springs, and 2,500 wells.

Construction of driveways and driftways is needed to move sheep and cattle to and from ranges, and to make passages through dense or down timber. Lack of these facilities is a major factor in poor livestock distribution and grazing use on many summer ranges. They are important on public ranges. About 4,700 miles of driveways and driftways

are needed, of which 3,000 miles are on public lands, principally Federal

The efficient handling of livestock on the range requires the use of structures such as cattle guards, loading corrals and chutes. These are needed mainly on the winter and spring-fall ranges of southeastern Oregon and southern Idaho. These measures apply to all ownerships, but the need is greatest on low-lying lands. Facilities needed number about 6,700. In addition, salting plans are needed for all rangelands to aid in controlling livestock distribution.

Benefits of the Rangeland Program

The increase in forage production that could be gained by the rangeland program outlined is estimated to amount to 11.6 million animal-unit-months of forage each year, once the program reaches full effectiveness. This benefit is the total from the 123.5 million acres of non-forested range and grazed forest land. In terms of beef equivalent, the additional forage production and the more efficient use of all forage will amount to 373 million pounds annually.

In addition to the benefits resulting from increased forage production, other benefits will be realized. Improved vegetation will increase soil stability and reduce erosion. Sediment from grazed lands will be greatly reduced. Percolation of water into the soil will be improved, storm runoff will be lessened, and damages from flash floods will be reduced.

Improvement of soil and cover and additional forage will result in increased stability for the range industry. More carefully planned management and use of the range will allow for variations in forage production caused by climate or other factors. Deterioration in soil conditions and the downward trend in productivity on the many millions

of acres of range now classed as poor can be reversed. As the range is rehabilitated, the productive capacity of the soil can be built up and saved for the future.

Big game as well as livestock can benefit from the program. Better distribution of seasonal use of the forage by domestic stock will reduce the present severe winter kill from starvation that has repeatedly cut down the deer and elk herds. Amounts of forage needed and taken by game animals have been considered in the program; certain measures have been included primarily for the game, to reduce their competition with domestic stock. Hunting will be improved to meet the increasing demand, and hunters will find game in better condition.

Forest Land

Timber is, and will continue to be, the major cash crop from the forest lands. However, the water produced as streamflow from forested areas, though it pays no direct return to the landowner is, in some cases, of equal or greater importance. The expanding development of the Columbia River Basin has been accompanied by an increasing demand for all forest products. This increase in demand has intensified the complexity of forest land management problems. These problems may be grouped into four broad classes: resource management problems, resource protection problems, land ownership problems, and utilization and other problems.

Management Problems

Uneven distribution of age classes of standing timber presents a serious management problem. For continuous production, the ideal forest would have equal areas of timber in each stage of development. Before the advent of the white man, the timber stands were composed

largely of mature and overmature trees, with young stands in the minority. The past century of logging and frequent large forest fires has changed the picture considerably. Today, there still is a substantial acreage of mature timber and an extensive area of very young trees, but a definite shortage of the age classes between. To prevent a decline in timber production, the harvest of the mature stands must be spread over the period needed for the young growth to reach useful size.

As the old-growth timber stands are harvested, the source of high quality timber is diminishing. In part the tendency of young timber to be limby and of poorer quality for lumber or veneer products can be counteracted by pruning trees that will be held for the final harvest. Growing conditions can be improved and growth rates increased by thinning dense stands of young growth and by weeding out competing noncommercial trees.

Much of the mature timber is vulnerable to windthrow and attacks by insects and disease and needs to be harvested soon if its values are to be retained. Such a harvest job requires a complete forest transportation network. There are many large roadless areas, and one of the most urgent needs is to build a road network that will make flexible and adaptable management possible so that orderly harvesting can proceed in any area and natural losses be held to a minimum.

Large areas of forest land in both private and public ownership are poorly stocked or non-stocked. Trees must be put on the land, either by planting or seeding, to make use of the productive capacity. To do this, fire hazards must be removed, competing vegetation eliminated, rodent populations temporarily controlled, and nurseries built to produce seedlings for planting.

Protection Problems

In the past, protection problems have received the major share of attention, but there remains much to be done. Extreme fire hazards still exist in some areas, and the level of fire protection needs to be raised over most of the forest land. When weather is abnormally dry and windy, major fires can and do break out and destroy large areas of timber. Excessively high peak flows were generated in 1948 on several watersheds that had not recovered from damages by fires years earlier. This contributed significantly to the damages done by the general flooding in the Basin. Fire hazards along roads and in areas of slash concentrations need to be reduced, and snags need to be felled in old burns.

Forests of the Basin are subject to damage from several kinds of insects. Among the most important insect enemies are the bark beetles and engraver beetles, wood-boring beetles, the spruce budworm, the pine butterfly, the Douglas-fir tussock moth, and the hemlock looper. Epidemics of one or another of these pests recur at various intervals and cause tremendous damage before they subside.

Protection against forest diseases is also of prime importance. Wood-decaying fungi, rusts, pole blight, and needle casts take a heavy toll from the trees of the Basin. Greatest losses occur in the valuable old-growth stands, where the volume of timber lost may equal or exceed the growth. In younger stands, inroads of disease may necessitate sharp changes in management and harvest plans. Seedlings and saplings are also subject to diseases that affect the establishment and vigor of new stands.

The various activities of management must be carried on so that they do not result in damage to the soil or to the streams. Access roads must be built according to specifications that provide for stable location, adequate drainage control, and a minimum of soil disturbance.

Timber harvesting must be planned to prevent equipment from doing damage to channels, to keep debris out of the streams, and to avoid excessive soil compaction or the creation of new drainage channels on the slopes. Recreation facilities should be developed with full provision for sanitation facilities to avoid possible stream pollution.

Ownership Problems

The ownership pattern on forest land also presents problems. The small size of many holdings is itself a deterrent to sustained yield management. Cooperative action is imperative in many phases of forest management and protection; fire, insects and disease take no account of property boundaries. Small intermingled parcels held by various owners make management less efficient for any of them. Blocking up ownerships is needed to improve management for both private and public owners.

Utilization and Other Problems

Utilization problems remain serious, although increasing demands for wood of all kinds have brought the less desirable species and the lower quality timber into wider use. There still are areas within the Basin, however, where it is not considered economic to harvest any but the best timber. Waste in the forest can be reduced still further, and must be, if we are to reach full realization of the productive capacity of our timberlands.

Another utilization problem involves access roads and balancing the timber harvest by age-class and area. Over much of the forest area of the Basin, deep snows prevent winter logging. It is important to reserve areas accessible the year around for winter logging to minimize seasonal variations in employment and production. Many stands which

should be thus reserved are being logged in the summer because of lack of access to stands which can be logged only in summer.

The problem of waste of wood both in the forest and at the mill is being attacked by development of equipment for handling timber more efficiently and by diversification in the wood-using industries. However, the lack of pulp and paper industries in the interior and eastern parts of the Basin is one factor which prevents making full use of the timber resource. Portable mills and logging equipment to handle small logs efficiently are needed. Conversion of mill residue to useful by-products has not yet reached a satisfactory level.

Progress of forest management has been slowed by tax structures which have led in the past to tax delinquency on cutover lands. Taxation procedures should consider the productive capacity of the land and the time required to grow a timber crop. Lack of adequate forest insurance and lack of low cost forest credit are two more deterrents to owners. For the small owners, marketing problems present a strong handicap.

Forest Land Program Objectives and Scope

The principal objective of the forest land program is to develop and maintain on a sustained yield basis a forest cover that will help provide, protect and regulate streamflow while producing adequate quantities and qualities of wood fiber, forage, wildlife, and opportunities for outdoor recreation. Meeting such an objective calls for sustained annual production of three billion cubic feet of usable wood fiber, including fourteen billion board feet (International 1/4 inch rule) of sawtimber. It requires also the application of multiple-use management to all forest lands insofar as compatible with the production of wood and water.

A wide variety of measures are needed to make management more

efficient, to provide recognition and facilities for all the forest uses, to balance the timber harvest between old growth and young timber stands, to open up areas now inaccessible, to reduce fire, insect and disease losses, to rehabilitate areas damaged by overcutting or fire or erosion, and to correlate management efforts guided by research and sound planning which must be in harmony with long-range needs. These measures are grouped into four major classes: those dealing with forest regeneration, those dealing with timber stand improvement, those dealing with utilization, and those dealing with forest protection. Facilitating and management measures will be dealt with in a later section covering all types of land.

Forest Regeneration Measures

Planting and seeding timber trees and associated measures such as rodent control make up the regeneration program and are needed on 7.4 million acres. This work will provide cover on nonstocked areas and will complete the stocking in thin stands. Before any trees can be planted in some areas, brush competition must be reduced. In other cases where direct seeding is to be applied, rodent populations must be decreased. More seed must be collected from the faster growing and more disease-resistant strains of forest trees; and nurseries must be expanded to grow more seedlings.

Areas to be seeded or planted have been chosen on the basis of their high potential productive capacity, their importance to industry because of accessibility, or of their importance in storing snow, regulating snowmelt rate and streamflow peaks and in stabilizing soil. Most of the regeneration work is needed within the two major commercial timber types, the Douglas-fir and ponderosa pine. Of the total area

needing this treatment, there are 3.3 million acres in Washington, 3.2 million in Oregon, 0.6 million in Idaho, and 0.3 million in Montana. The greatest part is west of the Cascades.

Though forest survey data indicate nearly ten million acres of forest land to be barren or poorly stocked, it is believed that some of these areas can be brought back into production by natural means aided by good management and adequate protection. Future planting requirements arising from the continuing timber harvest, fire, insect attack, or other causes will be taken care of currently by the continuing annual program. Planting and seeding where needed on freshly cutover lands is now handled as a part of the timber harvesting operation on many ownerships. It is assumed that this practice will be extended to all lands. In many cases natural regeneration is rapid and sufficient, but it is not always dependable.

Stand Improvement Measures

Timber stand improvement measures, including thinning, weeding, stand release, pruning, and controlled burning, apply both to natural stands and plantations. This work will increase growth rates, improve timber quality, and facilitate regeneration. It is needed on 7.0 million acres over the Basin.

Many potentially high producing areas are supporting young forest stands which have become stagnated because the trees are growing too close together. Thinning is needed to increase the growth rate. Pruning is needed in a considerable area of potentially high quality young timber now in the limby, small pole stage. Future production of quality timber is dependent upon pruning because of the dwindling reserves of virgin old-growth timber which until now have provided the high quality

products. Controlled burning is still another stand improvement measure which can be applied under favorable conditions in certain cover types and stands. Wherever applicable it is usually an economical way of reducing ground competition, ridding areas of undesirable growth, and preparing areas for natural reseeding.

It is presumed that when the backlog of stand improvement work is accomplished any recurring future needs will be cared for currently in conjunction with management and utilization. There is practically no stand improvement work being done at the present time except that which is being accomplished concurrently with or immediately after timber harvesting. So far, what has been done has been applied largely to the ponderosa pine type. Under the recommended program, however, nearly 30 percent of the work will be done in the Douglas-fir type.

Forest Utilization Measures

Forest utilization involves access road extension, development of improved equipment, and more complete use of forest products both in the woods where timber is harvested and in the mills where it is processed. The location of overmature stands necessitates a flexible management which makes possible operating immediately in localities where heavy losses are occurring or are expected. Where timber is allowed to go to waste, supplies of raw material for timber industries are reduced accordingly. Lack of an adequate road network has deprived industry of much timber in the past. The road shortage is most acute on public forest lands. This has resulted in a loss of public income, has placed a disproportionate cutting load on the more accessible private lands, has led to heavy cutting of immature second-growth timber, and has thrown summer and winter logging operations out of balance.

Until recently the timber industry of the Basin depended largely on high quality logs from preferred timber species. Ponderosa pine and white pine in the interior and Douglas-fir near the coast carried the industry. Associated species generally had little value. While utilization in the woods has improved markedly over the past thirty years, there is still much usable wood left unused. There is a need for logging equipment designed to handle small material efficiently, for portable sawmills to speed the handling of small logs, for development of pulp and paper industries in inland areas to make full use of the timber, for development of new products from present wastes.

Forest management also must concern itself with interrelations and conflicts between various forest crops and uses. Timber is the cash crop; but water is equally important, and may be affected for good or for bad by what is done with timber. Recreational use of forest lands is growing rapidly, and may have serious impact on other uses. Balance between uses must be reached; management therefore must adapt to constantly changing conditions. Careful advance studies of trends in uses and conditions are needed to assure a sound base for planning management policies and activities.

Forest Protection Measures

Forest protection is vital to sustained forest resource production, to erosion control, to regulation of streamflow, to prevention of excessive sedimentation and the allied impairment of water quality, and to lasting scenic and recreational enjoyment. Fire is potentially the most devastating of all natural enemies of the forest, yet present fire control organization and effort come the nearest to being adequate of all protection measures needed.

Protection against fire is a major need on most of the forest and

rangeland area. Present works and organizations must be expanded to afford the level of protection the forest and range resources warrant. With a growing population and increasing use of and demand for the timber, water, forage, wildlife, and recreation resources, the value placed upon these resources is increasing. But the greater the use, the greater the threat of fire, for most of the forest and grass fires that occur are man-caused. In less accessible rugged high mountain areas lightning fires are frequent and present another problem.

The protection program includes such things as erection of lookout houses and towers, clearing firebreaks, felling snags, disposing of slash and debris in high risk areas, developing water supplies, and constructing buildings for guards and suppression crews. Airplane landing strips, helicopter spots, and roads and trails for protection purposes are also needed. Lookouts are needed to improve coverage of forest areas and to speed up detection of fires while they are small. Clearing firebreaks is necessary to provide quick access, to break up areas of fuel, and to furnish lines from which fires can be fought. Opening up springs and seeps, building ponds and tanks, and clearing trails to streams and waterholes for tank trucks are also needed to improve fire suppression. Guard stations and suppression crew dormitories, smoke jumper facilities, warehouses and equipment depots are necessary for some of the less accessible areas, in order that men and tools may be available quickly when fires start.

The greatest amount of work is needed for hazard reduction and firebreak clearing in the heavily forested areas of western Oregon and Washington, northern Idaho, and western Montana. Disastrous fires occurred in these areas in eight years between 1929 and 1951. Large

fires will continue to occur in times of critical burning conditions unless the hazard is greatly reduced.

Distribution of the needed measures will be over an area of 100 million acres, 66 percent to federal, 26 percent to private, and 8 percent to state lands.

Benefits from the Forest Land Program

The program described to meet the needs will permit fuller use of the potential productive capacity of the forest land. Total wood production will be increased more than twice to meet the continuing demand and will be maintained at the new high level. In terms of sawtimber only, the benefits will ultimately reach an additional 6.5 billion board feet (International 1/4 inch rule) annually.

Thousands of acres of land now barren and denuded or invaded by brush and bracken fern will be put to growing trees again. Some of this land has been out of production for as long as fifty years, and some of it represents the best timber growing sites. This is land that was devastated by the repeated fires of earlier decades, or that was once cleared for farming and found uneconomic for such purposes.

Quality of the timber will be improved by thinning and pruning and by selection of parent trees for seed. Though we may never again reach the volume of high quality production that characterized the cutting in the old-growth forest, we will obtain through careful management better quality material than is now being taken from second-growth stands.

Since the forests of the Columbia River Basin produce a large share of the nation's timber, the benefits are more than local. Assurance of continuing supplies of timber will stabilize industries and communities, both within and beyond the Basin boundaries. Logging towns

will no longer become ghost towns, as many have in the past. Improved utilization will be accompanied by increased diversification, creating further stability. Greater protection of the forest resource against fire, insects, and disease will better preserve the timber supply, reducing present losses by three-fourths. It will thus make more timber available for use, and will protect the investment of the whole wood industry.

Even the forest management and protection organizations will benefit, by reason of reduced fire suppression costs. Such costs now average about $5 million annually; it is estimated that they will be cut in half. Other uses of the forest will also benefit, with reduced fire losses to recreational developments and to forage for game and livestock. With less burned area, there will be less ash and erosion sediment threatening water quality or silting up downstream water storage and diversion works.

Operations and management on forest lands will receive a significant benefit from the program. Planning and work will be concentrated on current--and largely foreseeable--needs. Improved access and communications will simplify and speed up all management activities. These and other management aids are considered in a following section, as applicable to all types of land; but their benefits to the forest are considerable.

Physical Programs Affecting all Classes of Land

Included here for the sake of convenience are those measures or groups of measures that are not limited in applications to any one class of land. They include controlling weeds, eradicating poisonous plants, reducing insect and rodent populations, combating plant diseases, improving fish and game habitats, and developing recreation areas and facilities.

Weed Problems and Control

The Columbia River Basin is threatened by the spreading of numerous weeds which cause considerable loss of crops and livestock. Many harmful weeds are well adapted to cropland conditions within the Columbia River Basin. Many also grow well on the ranges and other non-cropland areas which serve as sources of reinfestation for cropland. Waterways serve as a means of spreading seeds of weeds growing along the banks. Aquatic weeds quite often reduce the capacities of canals for delivering irrigation water.

Stands of undesirable vegetation create a Basin-wide problem on the rangelands. Some plants such as big sagebrush and rabbitbrush are relatively unpalatable and obstruct grazing use and range revegetation. Others such as larkspur, deathcamas, halogeton, and sneezeweed, are poisonous and cause livestock losses.

An effective educational program is needed to stimulate concern and interest on the part of landowners and operators to put into practice recommended control measures. Legislation may be needed to permit establishment of weed-control organizations to control weeds on public lands.

A major factor in weed control is preventing their becoming established. It requires an educational program to acquaint landowners and land managers with weed problems and weed damages and methods of avoiding them. State legislation to regulate sale or transportation of materials contaminated with weed seeds may be desirable. Adequate sources of clean crop seed are always necessary.

Since many serious weeds are already established throughout the Basin, control measures must be initiated and continually applied to check further spreading and to reduce existing infestations. The control program

must apply to all lands, and must have the support of all landowners, private and public.

The control measures to be used depend upon the weed species, the extent of infestation, the location, and the land use. The general control methods which may be used are clean cultivation, screening of irrigation water, selective and non-selective sprays, mowing, burning, and biological measures. It is estimated that about 697,000 acres of weed-infested cropland should have intensified weed-control practices applied to them. For all rangelands, it is estimated that weed control is needed on 4,488,000 acres. At present these lands cannot produce high yields in competition with the weeds and are a source of infestation for other lands.

Insect Pest Problems and Control

It is estimated that harmful insects reduce the total agricultural production of the Basin by 10 percent. Some act as carriers of serious human, animal, and plant diseases, while others cause damage by contaminating or destroying farm produce. Fruits, vegetables, seed crops and livestock are particularly vulnerable to insect attack. Insects often are a major contributing factor to poor range conditions where heavy infestations consume forage badly needed by grazing animals.

Many crop plants are attacked by insects such as aphids, grasshoppers, cutworms, leaf hoppers, and root maggots. Orchard trees and fruits are attacked by such insects as codling moths, leafrollers, and scale insects. On the rangelands, insects such as Mormon crickets, tent caterpillars, and grassbugs have weakened and reduced the density of desirable forage plants.

Insects present a constant threat to the forests. Leaf-eating

insects such as the tussock moth, the hemlock looper, and the spruce budworm, various beetles that feed on the inner bark of the trees, and some wood-borers cause serious damage to timber by weakening or killing the trees. Annual timber losses by insect damage may exceed the losses caused by fire.

Populations of insects may be kept under control in various ways. Crops in good growing condition are resistant to some insects. Others must be controlled by the application of sprays and dusts. While these control measures are now being carried on over the entire Basin, it is estimated that insect control is needed on 1,419,000 acres of cropland and 10,223,000 acres of rangeland.

In the forests, wherever insect infestations begin building up to epidemic proportions, emergency control measures are necessary. Leaf-eating insects are fought by spraying, bark beetles and wood-borers by spraying or by harvesting infested timber. Only recently have control efforts made significant headway. Most of the control so far has been provided by winter kill, fire, predators, and other natural factors. Insect infestations are controlled with difficulty once they reach epidemic proportions, and control action must aim at prevention of epidemics. This can be done most readily with a transportation system that makes all forest areas accessible for the control of incipient outbreaks and the removal of damaged timber.

An insect-control program is needed on 3.2 million acres of forest land. Needs are greatest in inaccessible areas and in overmature stands. The program would merely keep known and estimated future infestations under control until control measures become a part of recurring forest management programs. It is not intended to cope with large-scale disasters such as the Douglas-fir bark beetle epidemic now raging over

western Oregon forests or the spruce bark beetle threat in Idaho and western Montana. Such occurrences cannot be foreseen and must be handled as emergencies, though the program is expected to reduce their frequency and size. As soon as the forest stands are renovated, it will be possible to maintain adequate insect control at a reasonable annual cost and avoid the possibilities of devastating epidemics by means of continuous survey and prompt detection of attacks.

Rodent Pest Problems and Control

Many species of rodents cause damage to stored crops, growing crops, range forage, and timber throughout the Columbia River Basin. Rats do the greatest harm, as they destroy huge quantities of foodstuffs, kill poultry, and carry various diseases. On both croplands and rangelands, mice, rabbits, gophers, and ground squirrels feed on crops and forage and upset irrigation and drainage operations with their burrows. Periodic high populations of such rodents require extensive control to prevent excessive damage.

Thus far, there has been no effective rodent-control program for forest lands. Porcupines, mice, and ground squirrels have increased to proportions where they are doing appreciable damage in some areas. Porcupines affect a large portion of the pine forests, gnawing the bark and girdling young trees. Damage by mice and ground squirrels is limited to plantations and reseeding areas where they eat the seeds and the tender tops of young seedlings.

There are about 1,693,000 acres of cropland including farmsteads, to which some rodent-control measures may be needed. Baiting with poisoned grain is the primary control method; but construction of rodent-proof buildings and storage facilities is important in reducing rodent damage. On forest lands, local rodent concentrations need

control over a gross area of 4,760,000 acres, in the neighborhood of young timber stands, plantations, and seeding areas where they are preventing satisfactory reforestation or are doing excessive damage to timber.

Plant Disease Problems and Control

Plant diseases caused by various fungi, bacteria, and viruses often threaten the success of farm and range and forest enterprises. The causative agents may be in the soil, airborne, or carried by insects. Plant diseases are expected to become increasingly serious as disease spread is made easier by intensified crop culture and increases in irrigated area. The success of individual crops may depend on the degree to which diseases are held under control. Entire crops may be destroyed or production greatly reduced if diseases are unchecked.

Epidemics of smut or rootrot or blight may be brought on by unusual climatic conditions, and though local in extent often cause serious damage to crops and range forage. Diseases such as white pine blister rust, trunk rots, rootrots, needlecasts, blights, and cankers take a heavy toll of timber in forest areas. Mistletoe, though not in the class of the other disease agents, is particularly harmful in some ponderosa pine stands.

On croplands, plant diseases may be kept down by planting disease-resistant strains, by preventive spraying, by the use of certain crop rotations and cultivation practices, or by removal of alternate hosts for the disease organisms. In the forests, many tree diseases may be prevented by keeping the stands in thrifty growing condition, by thinning and salvage to remove trees weakened by crowding, fire, insect attack, or windthrow, by selection of disease-resistant strains for planting,

and by removal of alternate hosts. The success of sanitation measures in the forest depends on adequate access and regular surveys for prompt detection of disease outbreaks. Restrictions on transportation of infected plant material is another means of preventing introduction and establishment of disease.

Current disease-control programs on crop and range lands involve such measures as chemical treatment of seeds before planting, the use of chemicals for soil sterilization, regulation of irrigation, removal and destruction of infected plants, and the application of fungicide sprays to the growing plants. More intensive control programs are necessary, for despite current efforts, crop losses by disease are estimated at $20,000,000 annually in the Columbia River Basin. Success of these programs depends on the continued and increased cooperation of all landowners and operators.

On forest lands, disease control involves removal and destruction of infected trees, salvage of damaged timber, and eradication of alternate host plants. Management of the forests must be planned to include regular disease-detection surveys so that affected areas can be cut over and the timber salvaged. In the case of the blister rust which threatens to eliminate white pine completely, removal of the alternate hosts must be continued indefinitely, until disease-resistant strains of white pine are developed and established in the forest. Both control of forest tree diseases and salvage of damaged timber require an adequate road system for access.

Fish and Wildlife Habitat Improvement

The Columbia River Basin is richly endowed with a wide variety of game animals, fish and furbearers. As population increases and

the resources of land and water are more fully developed, the changes will strongly influence wildlife. Coordinated land management that includes wildlife becomes more important, if old problems are to be solved and new ones are to be prevented.

Impounded waters upset fish and game habitats. Abnormal streamflow below storage reservoirs interferes with migration, spawning, and fish life. Construction of high dams blocks the migration of seagoing fish, denying former spawning grounds to them. Debris jams that result from logging and forest fires also block movement of fish. Diversions of water for various purposes affect the downstream passage of young fish to the ocean by reducing streamflow and by diverting the fish also. Mining and other industries have so polluted the waters of many streams that they no longer provide favorable wildlife habitat. Return flow of irrigation water raises the salt content of many streams. Ashes and silt from burned areas wash into the streams, poison the fish, smother aquatic growth, and bury gravel beds important as spawning areas. Removal of shade along streams by logging and fire affects stream temperatures. Erosion sediments from cultivated lands, overgrazed ranges, and forest lands distributed by fire or logging change the stream habitat profoundly. Because so many streams have already been spoiled as wildlife habitat, it is imperative that waters that still provide good fish habitats be protected and developed.

Management of wildlife is difficult because of divided responsibilities. Many of the big game ranges and migratory fish spawning grounds are on federal lands. The habitat is managed by Federal agencies, while the management of the fish and game is a responsibility of the states. Conflicts between big game and domestic stock create problems. Large areas of big game winter range are privately owned; the animals

eat stacked hay, damage orchards, and break fences, bringing many complaints from landowners. Big game also pose a problem to regeneration of timber species on some forest land. Other wildlife problems have been cited in the section on rangeland.

To improve game habitat and forage, plantings are recommended for 1 million acres, primarily on public range and forest land. Grasses, herbs, and shrubs will be planted for cover and food for migratory waterfowl and upland game birds and for big game forage; and aquatic plants for fish and waterfowl. Nearly 5,400 miles of streams, and 38,730 acres of lakes are in need of further work such as clearing and cleaning, installing dams and deflectors, and improving spawning grounds. Migratory waterfowl need sanctuaries and resting places; 235 water developments are needed for this purpose. A total of 284 fish hatcheries and rearing ponds, mostly the latter, are needed to facilitate the propagation and distribution of game fish.

These projects are needed on public lands to meet the rapidly increasing public demand for fishing and hunting. About three-fourths of the work will be done on Federal lands. By states, the work is distributed about 40 percent to Oregon, 33 percent to Idaho, 14 percent to Montana, 10 percent to Washington, and 3 percent to Wyoming.

Recreational Developments

Many activities are included in recreational use of the lands of the Columbia River Basin. The majority of use is by campers, hikers, picknickers, and tourists viewing the scenery in forest areas. But fishermen pursue game on range and cropland as well as in the forests. Recreational use occasionally creates some conflicts with other uses, and certain problems have appeared. With recreational use on the increase, such problems become more and more important.

In areas of intense recreational use and development, grazing and logging may be undesirable. Where scenic values are high, logging is detrimental. On the other hand, recreational use and entry must be restricted on domestic water supply watersheds. The big problem, however, is keeping recreational developments up with demands. Many of these developments are necessary to control the use. For example, recreational use increases the likelihood of fire occurrences; recreational developments are therefore placed where fire risk is low and suppression least difficult. With 24 million visits made in one year to national forests, national parks and monuments, and state parks, management of recreational use has become a big job.

To meet the demands of the constantly increasing throngs of recreationists, the program includes construction of various recreational facilities such as campgrounds, picnic areas, bath houses, and shelters, and the preparation of winter sports areas, organization campgrounds, and summer home sites. A total of 34,606 such installations are needed. Nearly all of the proposed developments will be on Federal land. By states, the projects are distributed 40 percent to Oregon, 25 percent to Washington, 23 percent to Idaho, nine percent to Montana, two percent to Wyoming, and one percent to Utah and Nevada.

Special Water Conservation and Flood Prevention Measures

Water is one of the most valuable resources produced by a large part of the watershed of the Columbia River Basin. Continued expansion of the agricultural and industrial economy is largely dependent upon the development of this resource. Problems of floods, sedimentation of stream channels and storage facilities, seasonal water shortages, and water pollution have increasingly hampered development. These problems are the result of several basic causes.

Major Problems

The seasonal flow of most streams is such that during the periods of maximum water requirements for agriculture and industry the flow is at a minimum; and the maximum flows not only are wasted but may cause damages by flooding to agricultural, industrial and urban developments. This problem is being partially solved by public and private projects which provide storage facilities for some of the surplus waters. These assist in flood control and make additional water available during periods of shortages. Benefits from these projects accrue largely to downstream interests in the way of generation of power, water for irrigation and industry, and improved navigation on the Columbia River.

Occupancy and use of the land are important factors related to water problems. Many farms, towns, and even some large cities are so located that they suffer flood damage during occasional high stream flow.

Improper treatment and inadequate management of the basin watershed lands are major factors contributing to its water problems. Water conservation and control are inseparable parts of good land management. Every use of the land - crop production, timber production, grazing, mining, recreation, or transportation must be made with careful regard for this fact. Prevention of flood and sediment damages, maintenance of high quality water, and to some extent control of seasonal distribution of flows depend to a large degree on favorable watershed conditions.

Flood water and Sediment Damages

Floodwater and sediment damages occur when channel, stream, or river capacities are exceeded and the excess water causes overland flow, inundation, erosion and sedimentation. Sediment damage may be suffered even though overbank flow does not occur. In addition to the physical

damages caused directly to property by floods, there are indirect damages. Such damages may include losses caused by interruption of service; the cost of evacuation and reentering premises made uninhabitable by floods; the costs of rescue work; the costs of caring for the sick and injured; the cost of traffic interruptions and rerouting; and losses of income.

Table 12 summarizes the average annual floodwater and sediment damages for areas that will not be protected by existing or authorized projects. These damages are divided into two broad categories, agricultural damages and other damages.

Damages to agricultural lands, property and crops are caused by water, sediment, and a combination of floodwater and sediment. These damages are largely associated with farm and ranch operations and occur primarily in cropland areas.

Floodwater damage is damage caused by physical contact with flood waters. Losses under this category include those of crop loss and reduced crop yields; damage to buildings, equipment, and fences; livestock losses; costs of cleanup and repair; and land loss by streambank erosion, major scouring and valley trenching.

Sediment damages are those damages resulting primarily from deposition of debris or sediment. They include such things as the deposition of sterile sands and gravels to depths great enough to remove the land permanently from cultivation, lesser deposition which reduces productivity and crop yields, flood-borne weed infestations, damage to buildings and equipment, and costs of cleanup and land relevelling.

Certain damages could not be divided between floodwater or sediment as to main cause and are set out in a combined floodwater and sediment class. It includes damages to reservoirs and major water distribution works; to farm irrigation and drainage systems caused by breaks, debris

Table 12.--Average Annual Floodwater and Sediment Damages for Areas Unprotected by Authorized Projects, Columbia River Basin Area, Based on 1949 Prices

State	Agricultural Damages				Other Damages					Total All Damages
	Flood-water	Sediment	Flood-water & Sediment	Subtotal	Transpor-tation Systems	Irrig. and Drainage	Urban and Indust.	Reser-voirs	Subtotal	
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Washington	2,727,600	1,440,500	366,300	4,534,400	2,567,500	513,400	15,000	133,200	3,229,100	7,763,500
Oregon	1,108,600	476,000	363,800	1,948,400	2,093,500	135,200	109,600	123,100	2,461,400	4,409,800
Idaho	817,200	239,900	66,000	1,123,100	852,700	268,900	453,200	252,100	1,826,900	2,950,000
Montana	235,900	4,000	38,700	278,600	411,200	2,600	26,900	20,300	461,000	739,600
Wyoming	25,000	5,200	10,100	40,300	16,600	13,300	1/	6,500	36,400	76,700
Utah	1,900	1/	100	2,000	700	1/	1/	100	800	2,800
Nevada	20,400	1/	400	20,800	8,000	15,500	1/	4,500	28,000	48,800
Total	4,936,400	2,165,100	845,400	7,947,600	5,950,200	948,900	604,700	539,800	8,043,600	15,991,200

1/ Data not available

and deposition removal, and headworks dam or diversion replacement or repair; to farm bridges and roads; and to other types of improvements.

Other evaluated damages include a combination of floodwater and sediment damages, but not those generally associated with farming operations. These damages occur about equally on the various stream flood plains and on lands above the flood plains. Types of damage included were those to transportation systems, to irrigation and drainage systems, to urban and industrial developments, and to reservoirs and stock ponds.

Transportation systems include all roads and trails on public lands, all other public roads or highways, and railroads. The types of damage covered were those of washout or breaks of roadbed or fills, scouring of or deposition in roadside ditches, loss or damage of drainage structures or facilities, sediment or debris deposition on roadbeds or rights-of-way, and other types of road damages.

Damages to irrigation and drainage systems include those to major distribution systems, diversion structures, or drainage systems serving more than one farm. The damages are over and above those tabulated under agricultural damages. The types of damage include system breaks caused by floodwater or sediment, damages to headworks or diversions, clean out costs for removing debris or sedimentation from canals, laterals, syphons, sediment basins or against tide gates.

Damages to urban and industrial developments occur almost wholly on flood plains of the various streams. Included are damages to or destruction of buildings or their contents; damage to public utilities such as telephone, telegraph, power facilities, streets, municipal water systems, and sanitation systems; clean-up costs; other urban damages; and damages to mills and log ponds.

Damages to reservoirs or stock ponds result primarily from sedimentation. Such damages include the loss of storage capacity, deterioration of storage water quality causing increased filtration or chlorination costs, loss of reservoir or stock pond facilities by breaks or washouts, and other damages.

There is also a miscellaneous category of unevaluated damages which includes all other types of damages not considered under other headings. It includes a part of the damages to recreational facilities, to fish and wildlife, and various other damages which are largely intangible. In addition there is a sizable group of damages which is completely intangible. Though not evaluated in monetary terms because of their intangible nature or the extreme difficulty of evaluation, these damages are very real and their effects are widespread. They include the loss of life from floodwaters, mental distress caused by fear of floods, general fear or insecurity, sickness resulting from floods, disruption of communications, social and aesthetic losses and other losses having a bearing on the well-being of the community. Much of the loss in land productivity by erosion or deposition is also in this category.

Water Control Aspects of Land Treatment Programs

Several of the program measures needed for forest lands will produce benefits in terms of water conservation and flood control as well as in terms of increased timber production and other on-site benefits. Some of the measures would be applied primarily for their value in water conservation and flood control. Fire protection, for example, would be provided for noncommercial forest lands on watersheds where loss of cover would lead to destructive flooding or to impairment of

water quality. Maintenance of cover will hold soil erosion in check and permit infiltration rather than rapid runoff of surface water.

Regeneration of forest cover on areas already damaged by fire or other causes, is planned for watershed areas as well as for commercial forest areas. Of the 7.4 million acres in need of tree planting, nearly all will provide flood prevention benefits, and a significant acreage is included for that purpose alone. Effects will vary according to topographic position and relation to flood damage areas.

Other forest program elements will also show similar benefits. The disease and insect control measures will help accomplish the fire control objectives. The timber harvest, extending back into areas of heavy snowfall, will help control the catch and melt rate of the snow by controlling the size and location of forest openings and thinnings. Correction of present inadequate drainage facilities and stabilization of open cut and fill slopes along the access road system will eliminate a primary source of stream sediments and turbidity. Improvements in location and construction of future roads will avoid further trouble in this regard. Better care and supervision in logging operations will reduce soil disturbance, reduce erosion losses, permit greater infiltration, reduce surface runoff and flood damages, and help maintain water quality.

The same principles may be applied to the range program measures that serve to improve the plant cover. Seeding and planting grasses and shrubs will increase cover density, stabilize the soil against erosion, and promote greater infiltration of surface waters into the soil. Controlled grazing use through better management and closer supervision will make possible the rehabilitation of areas with scant cover and compacted eroded soil now contributing to flash floods and

heavy stream sediment loads. Most of the needed 11,392,000 acres of seeding and planting, the 620,000 acres of waterspreading, the 5,591,000 acres of range fertilizing, and the various phases of management improvements will produce considerable reductions in streamflow peaks and in erosion and sedimentation. Again, some of these measures are needed for flood control and water conservation purposes alone, because of the great benefit to be derived therefrom. A further benefit from the improved management will be a reduction in the water pollution hazard, an important consideration in certain watersheds.

The installation of the measures and practices needed for cropland will be effective in increasing infiltration and the water-holding capacity of the soil reservoir. Cover crops, crop rotations and crop residue utilization are practices which achieve these effects by improving the structure of the soil. Terraces, subsoiling or chiseling and contour cultivation mechanically increase infiltration by withholding the runoff waters and allowing a longer period of time for them to gain access to the soil reservoir. This increased retention of water in the soil reservoir reduces the amounts of precipitation lost to runoff and delays the concentration of the runoff waters that are not permanently retained by the soil.

In addition to reducing the flood peaks, conservation farming reduces the damages that are caused by sedimentation, as a result of controlling erosion on the cropland areas.

Water Control Benefits of Land Treatment Measures

For each class of land, the effects of various needed program measures have been described generally in terms of infiltration, erosion, runoff, and sedimentation. By analytical methods which considered land

use, land condition, rainfall, snowmelt rates, topography, and other physical factors, a more specific determination of the combined program effects was made. It was found that the program would ultimately provide reductions in streamflow peaks ranging from five to thirty percent for various areas and conditions. Reductions are greatest in the smaller tributary watersheds, and on the more frequently occurring smaller floods. Certain measures will become fully effective immediately; others will require several years to attain full effectiveness; while a few will require a much longer period before maximum benefits are attained.

The range program on the open rangelands will provide reductions in local summer cloudburst flood peaks of 5 percent to 15 percent. West of the Cascade Range the needed cropland and forest land programs together will prevent the more frequent flood peaks from increasing 20 to 30 percent. A little more than two-thirds of this reduction will be brought about by the forest program alone. In mountain watersheds east of the Cascades, the forest program will provide from five to twenty percent reductions in snowmelt flood peaks. Over the entire basin, as the measures become fully effective, the average reduction in flood peaks is estimated to be approximately 13 percent on tributary watersheds.

The fairly wide range in variation of the reductions cited is due to several factors. In some watersheds, conditions are still very good, and the program will provide but small improvement. In others, unfortunately the majority, conditions are less desirable because of past land abuse, and the program will provide marked improvement. Without the program, and with a continuation of present encroachment upon

heretofore undisturbed areas and intensification of current activities, flood peaks may be expected to increase. The program will reverse this trend.

Reductions in sedimentation will also be provided by the program through the many measures that stabilize soil and prevent excessive erosion. Without the program, sedimentation is expected to increase. Similar to flood peak reductions, the effects on sedimentation will be variable. They are estimated by procedures similar to those described above, and range from 10 to 70 percent of the present stream sediment loads. Over the Basin as a whole the sediment reduction will amount to about 26 percent. Sediment discharge of the Columbia River is estimated at 19 million tons per year, and the reduction will amount to 5 million tons annually.

Other benefits will be gained. With reduced erosion on the slopes and less sedimentation and turbidity in the streams, water quality will be maintained at relatively high levels. Generally, the need for and cost of water treatment for particular uses will be reduced. Stream channels will furnish better habitat for fish life, with less danger of smothering eggs and fry in the spawning grounds, with fewer and less violent changes in the stream channels by flood action, with less debris contributed to channels by operations in watershed areas, and with less wide fluctuation in streamflow.

Independent Structural Measures

The land treatment program needed often will not be effective immediately in waterflow retardation and erosion prevention. In addition, such measures alone will not suffice because of the severe erosion which has occurred in the channels of many tributary streams. Therefore, various

types of channel improvements of a structural nature are required. These measures, including channel clearing, channel enlargement, channel alignment, revetments, riprap, jetties, lined channels, check dams, gully stabilization structures, diversions, floodwater storage dams, and sediment detention reservoirs, will supplement the land treatment program and provide immediate protection against local flood and sediment damages.

This group of measures will be applied to flood and sediment damage trouble spots in the tributary areas. They are related to, but quite independent of, the measures described in preceding sections. Likewise, they do not conflict or compete with the major downstream river improvement works of other agencies.

Such structural measures are designed to provide for the orderly disposal of runoff so that damaging flows can be conducted safely past vulnerable areas, or by a combination of reservoir and channel works. The structures or measures vary in size, purpose and degree of control, depending on nature of the problems, flood characteristics, and local conditions. West of the Cascade Range a large proportion of the heavy precipitation occurs during the fall and winter seasons when frequent high flows cause loss of life anddamage to soil, crops, livestock and public and private improvements.

Roads and other encroachments on channels and clogged drainageways are common and the flood relief measures are designed accordingly. In some cases, providing a channel capacity to accommodate annual or frequent flows will make some land available for more profitable agricultural use.

East of the Cascade Range most winter precipitation falls as snow which may produce high flood flows following the spring thaw. Total precipitation is much less than along the coastal area, but stream erosion problems are more acute. Tributary channels are relatively deep and

channel capacities are more nearly adequate for the frequent flood flows. However, intense summer storms extending over relatively small areas are common to this part of the Basin. Such storms produce high damaging peak flows on local tributaries, and cause serious channel cutting. The major problem within the channels is one of grade and bank control, as contrasted with the emphasis on water removal in the area west of the Cascade Divide. The specific measures included in the program are grouped under five categories.

Tributary channel improvements include the installation of log, rock, piling, and other revetments, tetrahedrons, riprap and paving work, channel realignment and enlarging, and associated measures needed to control tributary streams in local areas, for protection of crops, other private and public improvements, and reduction of sediment production and sediment damages. About 8,350 miles of tributary channel improvement are needed.

Waterway stabilization and control structures have as their primary function the reduction of channel erosion. They include large check dams, diversion works, head controls and other measures to stabilize large arroyo-type gullies and stream beds. They reduce the velocity of water moving down the channel and effect some reduction of flood peaks. They can be used often in combination with irrigation diversions where one structure will serve both purposes. In the Basin, about 780 such structures are needed.

Dikes and levees are earthen structures with or without riprap protection to be installed along streams to provide increased stream capacity and to protect land and property from flooding and damaging sediment deposits. When building dikes and levees excavated material is used to increase channel capacity beyond that obtainable by excavation alone. About 75 miles are needed along small streams throughout the Columbia River Basin.

Floodwater storage and retarding reservoirs are needed to store, retard or detain excessive runoff from rain or melting snow. They are valuable in controlling flash floods from summer thunderstorms. All such dams will be earth fill construction from materials available near the site and equipped with adequate spillways and having ungated outlets with capacities limited to the capacities of the channels downstream. Some 30 of these structures are needed.

Sediment detention dams are utilized to protect highly developed areas or expensive improvements. They serve as debris basins or catchment areas and are used to stabilize placer deposits, provide a settling basin for upstream contribution of sediment, and catch the coarser materials being carried or moved in channels. Much of this debris moves down channels with runoff from high intensity or cloudburst-type storms. Such storms are frequent, are of limited areal extent, but are of unpredictable occurrence and highly destructive force. The basins are formed by building dams or levees in such a manner that a catchment area is provided. The outlet is protected with a permanent structure. The successful functioning of such a dam or structure depends on spreading out the flow and reducing its velocity and carrying power sufficiently to drop the coarse sand, gravel and boulders being carried before the flow emerges from the storage area through the protected outlet. Needs include the installation of about 115 of these structures or dams. Many would be located at points where steeply sloping channels emerge onto relatively flat plains or fans. They are required for the protection of such areas as the apple orchards along the Columbia River, truck croplands in western Washington, and other highly developed areas subject to damage by debris.

Additional multi-purpose water storage structures are needed and the

program includes recommendations for survey and investigation. In some watersheds the practical control may be to construct relatively small dams on tributary streams to store temporarily some of the excess floodwaters for later release at rates not exceeding the capacities of existing or improved channels. These reservoirs can usually be designed for multiple purposes. Reservoir storage has values for many purposes other than flood control. The storage of water for irrigation is important in the attainment of the full productivity of the watershed lands. Values for recreation and fish and wildlife provide additional justification for reservoir developments. Planning a reservoir development to satisfy only one need often complicates the later solution of the remaining water problems in the same area. The most efficient solution of all problems requiring water storage is to design projects which provide for all water needs in multiple-purpose structures.

In some instances the full storage capacity of a multiple-purpose reservoir might be used for flood control purposes during the period of usual flood hazard and also be used to provide the required irrigation water by storing streamflow when the period of maximum flood hazard has passed. In other instances it may be necessary to provide design capacity primarily for the storage of irrigation water. Hydroelectric power development and needs may also be considered. Provision for a permanent pool in the reservoir could be made in deference to recreational or fish and wildlife requirements. The separate solution of a single water storage requirement may not be economically feasible while the simultaneous solution of all the water storage requirements of a watershed, by use of multiple-purpose structures, may result in a very favorable benefit-cost ratio.

The total feasible program for multiple-purpose reservoirs was not determined due to limitations in survey resources. To determine and

evaluate all of the physical and economic factors associated with the feasibility for all possible developments of this type are not within the province of this report. Each possible development of this type should be investigated in detail as specific interest is expressed by groups which would benefit by its multiple-purpose functions.

West of the Cascade Range the full storage capacity of reservoirs can generally be used to control floods during the flood season and yet store enough water for irrigation needs from the late spring flows. In this area about 380 sites are considered as having possibilities for multiple-purpose reservoir development.

East of the Cascade Range there is need for additional irrigation water in most of the cropland areas. Many of the smaller and a few of the larger irrigation enterprises have a serious water shortage during the latter part of the growing season. In this area it would generally be necessary to store the water required for irrigation during the flood season. Streamflow does not remain high enough thereafter to fill reservoirs for summer use. This requires that part of the design capacity be primarily for the storage of irrigation water and not for flood control purposes.

It was estimated that favorable sites and conditions could be found for about 1,000 multiple-purpose reservoirs east of the Cascades. Over the Basin as a whole, it is estimated that surveys will be needed for a total of about 1,400 such structures. Reservoirs would vary in size from a few hundred to several thousand acre feet of capacity. They would require dams of from 50 to 150 feet high which, in the majority of cases, would be of the earth-fill type. Although these structures would be recommended by the Department of Agriculture following favorable survey findings, they might in many cases be built by other agencies.

Benefits of Independent Structural Measures

Several kinds of benefits accrue to the structural measures for water conservation and control. Immediate reductions in flood peaks, in sediment loads, and flood and sedimentation damages will be gained. Increases in water conservation will result by reason of improved low-season flow from the storage and gradual release of flood waters otherwise wasted. Greater availability of water will provide additional water for lands being irrigated with insufficient supplies, and for additional areas to be irrigated. Regular streamflow, decreased turbidity and sedimentation, and stabilized stream channels will improve the habitat for fish and riparian wildlife.

The value of these benefits is estimated to exceed the costs of the structural measures, and will for the most part be received over the period that is needed for the land treatment program to become fully effective. There will also be residual benefits resulting from the structural program, over and above those benefits ultimately attributed to the land treatment program.

Illustrative of the physical benefits accruing from the independent structural measures is the reduction in the average annual floodwater and sediment damages. It is estimated that the independent structural measures, when installed, will reduce average annual floodwater and sediment damages by the following percentages:

Floodwater damages to crops and property	60 percent
Floodwater damages to land	60 percent
Sediment damage to crops and property	20 percent
Sediment damage to land	75 percent
Floodwater and sediment damages to roads, bridges, irrigation and drainage systems and farm ponds	50 percent

In addition to the damage reduction, other tangible benefits in the way of increased crop yields, improved use of lands and enhancement of land and property values will result.

Facilitating and Management Measures

Administrative Facilities for Public Lands

The measures in this category include construction of access roads, trails, airfields, telephone lines, and buildings, and the installation of radio and other special equipment. The most needed single program measure and the one most essential to the development of the forest resource is access road construction. Many miles of road are required for adequate protection and management and for proper utilization of the forest.

Construction of some 38,800 miles of road is needed. One-third of this mileage is reconstruction. This does not include strictly timber utilization roads which will be built on public lands by the private operators contracting for the timber harvest. About 94 percent of the road building would be on Federal land, and six percent on state lands. Of the total mileage, 31 percent would be in Idaho, 23 percent in Washington, 27 percent in Oregon, 16 percent in Montana and three percent in Wyoming, Utah, and Nevada.

Primarily to help forest protection and management activities, but also to improve recreational use, 27,600 miles of trail are required. Federal lands would have 96 percent of the trail construction, state lands 3 percent, and private lands 1 percent. By states, Idaho would have 30 percent of the total mileage, Washington 27 percent, Oregon 20 percent, Montana 15 percent, Wyoming 7 percent, and Utah and Nevada 1 percent.

Other transportation facilities needed to improve protection and management include about 145 airfields and 3,275 helicopter landing spots. Ninety percent would be on Federal lands, six percent on state lands, and four percent on private lands.

Communication facilities also need considerable expansion to provide better protection to the forest resource. In consequence, there is a need for the construction of 6,200 miles of telephone line, the installation of accessory switchboards and other equipment, and the installation of 3,100 fixed and mobile radio units and repeater stations. Of the telephone mileage, 96 percent would be for Federal lands, 3 percent for private, and 1 percent for state lands. Radio installations are 74 percent for Federal lands, 17 percent for private, and 9 percent for state lands.

Buildings of various kinds are needed, both in remote locations and in communities with limited rental space available to attract and hold capable employees close to their work areas. Nearly 7,500 dwellings, offices, warehouses, garages, and utility buildings must be rebuilt or added to the present management plant. More than 4,000 water and sanitary systems need to be improved or developed in connection with the buildings. Ninety percent of these installations apply to Federal lands.

In connection with recreational use on public lands, numerous cleanup and disposal projects are needed around campgrounds and scenic areas and along roads. The work would be distributed 45 percent to Idaho, 28 percent to Oregon, 15 percent to Washington, and 12 percent to Montana.

Management Aids

A phase of the program important to its final integration and success consists of the development of plans for handling the various resources. These plans must be continuing and comprehensive; and though

developed separately for each resource or use, must harmonize all uses. Illustrative of the magnitude and complexity of program correlation and integration would be the various forest land programs. At least 12 separate programs, such as timber management, fire control, watershed management, recreation and insect control, are involved. Many, if not most of the various plans, would apply to the same acreage. Total area to be covered by the several plans amounts to 125 million acres.

Evaluation surveys are needed for checking on progress of the program and for keeping record of status. Included are such surveys as those on blowdown and insect damage in the forests, on tree disease outbreaks, on range condition, on forest tree growth, on game populations, on recreation use. These measures are included with the forest, range and other programs.

On public lands, both forest and range, the program calls for intensified management to protect and develop the forest, forage, water, wildlife, and recreation resources. This will apply to 90.3 million acres of land.

Technical Assistance

Technical assistance to owners of the smaller tracts of forest land is necessary to enable them to get the greatest use and high production from their lands. The owners of the larger commercial tracts are now employing technical foresters, or using the services of consulting foresters, and the program does not contemplate direct public participation in providing technical assistance to such owners beyond the usual interchange of information and research findings. But 5,197,000 acres of the best forest land are in private ownerships averaging about 160 acres each, and are not parts of self-sustaining commerical forest operations. It is to these that the program is directed. Proper management on these lands will result in public benefits in terms of

increased timber production, reduction of fire, insect, and disease threats, etc. The program therefore provides for 70 foresters under the direction of the various state agencies or departments to aid small forest owners. At present only about 15 foresters are so employed.

Technical assistance to plan and supervise the installation of the measures and practices recommended for private cropland and rangeland can be obtained through various types of districts, such as, soil conservation or flood control districts. Considerable progress is being made at the present time in the adoption of conservation farming methods, but both public and private interests would be served by acceleration in the application of the needed program. A greater amount of technical assistance will be required as the people come to realize the advantages of the program more fully.

Institutional Adjustments

The mixed forest land ownership and management pattern requires analyses and planning to unify management and utilization practices. There is need for some transfer of ownership through purchase or exchange. Lands which can be properly managed and profitably retained in private ownership should remain there. Lands in need of rehabilitation and which cannot be retained profitably in private ownership should be in public ownership.

However, it is neither desirable nor practical to strive for good management and utilization through changing the ownership pattern alone. Of equal or greater importance is the need for a program of cooperative effort whereby all owners and agencies manage and utilize the forest and water resources of logical working circles or management units on a correlated sustained yield basis. There are two aspects of the management and utilization program wherein inter-

agency cooperation and correlation of effort will be of utmost importance. These are distributing the cut of remaining mature timber over the period required to bring young stands into production so as to cause the least possible disturbance to local and national economy, and currently salvaging timber damaged by fire, insect and disease so as to hold gross losses to a minimum.

There is also need of a program of consolidation of responsibilities, particularly Federal, in a few logical management units where duplication of effort now exists.

To promote private forest enterprise to the greatest extent practicable, the forest tax, credit and insurance situations should be improved. The methods of taxation should be changed in most localities if forest lands are to be held in private ownership over the long crop rotation periods required to grow most commercial forest products. Credit extension in the form of low-rate, long-term loans is essential if any appreciable amount of non-stocked private forest land is to be rehabilitated and retained in private ownership. A program of forest insurance is needed to afford private owners protection against insect, disease and fire losses. Credit extension and forest insurance may result from some form of a cooperative program. The taxation program is a responsibility of the states and local government.

Legislative needs of the program include enactment of appropriate forest legislation where nonexistent, and strengthening of existing legislation where necessary so that development, management and utilization practices are in harmony with long-range local and national requirements for forest and water resources.

Among the more urgent legislative needs are those pertaining to forest cutting practice standards, forest land cover requirements,

waterway channel and streamside protection standards, including pollution and sedimentation prevention. Several states have legislation dealing with one or more of the above, but some strengthening is desirable to meet long-range social and economic requirements. Less urgent, but still important, is the need for revising and strengthening some state forest protection laws. Most states have good fire protection laws and the ways and means of implementation. Likewise, most states have legislation dealing with forest pest control - insects, disease, and rodents, but generally implementation is inadequate. State protection laws need be amended to serve adequately all phases of forest protection including cooperative control action among forest land managing agencies and owners. Slash disposal and fire hazard abatement legislation, too, needs strengthening in Montana, Idaho, and the area west of the Cascades.

An extremely important part of the legislative program is the need for revising the Federal mining laws. They need to be amended to eliminate improper and to lessen conflicting use of Federal forest and range lands. Amendments should be directed towards harmonizing public land uses for the protection of overall public interests and the protection of the miner whose intent and purpose are the legitimate mining of mineral resources. At present there is an appreciable amount of misuse of Federal lands under the guise of mining. As a result public interests are being violated and considerable damage is being done to the natural resources.

Land Conversion

According to the physical characteristics which determine land capability, there are 1,241,000 acres of rangeland and 1,145,000 acres of forest land in land capability classes I to III that could

be used as cropland should economic and other factors permit. Conversely, there are 628,000 acres of cropland, unsuited to their present use, which should be put to less intensive range or forest uses.

Certain conversions would be economically feasible at present; others may never be. Some land better suited to forest is now being used for crop production or for grazing without much profit and to the detriment of the land itself. It would return profits without land deterioration if put back into forest. There are numerous small tracts of forest land totaling more than 300,000 acres that should ultimately be added to adjoining operating farm units and converted to cropland use.

Electrification and Communications

Electrification

About 95 percent of the farms in the Basin were electrified on June 30, 1952, as compared with 88 percent of all farms in the United States. The percentage of the electrification was highest in the State of Washington where 96.5 percent of the farms were electrified.

The use of electricity on farms in the Columbia River Basin is high in relation to the average use for the United States. In 1952, farms served by REA borrowers in the Basin used an average of about 5,500 kilowatt-hours annually, as compared to 2,160 kilowatt-hours for all farms in the United States served by REA borrowers. A recent study shows that farms in eastern Washington used an average of 9,845 kilowatt-hours of electricity in 1948.

The principal factor accounting for the greater use of electricity on the farms in the Columbia River Basin is the low cost power available. The average national cost of electricity to farm consumers

of all REA borrowers in December, 1952, was 3.28 cents per kilowatt-hour as compared with 2.60 cents in Idaho, 1.73 cents in Oregon, and 1.64 cents in Washington.

About 78 percent of electricity used on farms is used in the farm homes. Studies of appliance saturation in the Basin indicate that four household appliances account for approximately one-half of the per farm home kilowatt-hour consumption. These appliances and the estimated number of farms using them are: refrigerator, 95 percent; electric range, 55 percent; water heater, 50 percent; and freezer, 25 percent.

From the farmer's viewpoint there are many other appliances and items of electrical equipment which, though they do not require comparable quantities of electricity for their operation, have been at least of equal importance in saving labor, reducing production costs or contributing to better rural living. In dairy and poultry types of farming areas, for example, as much as one-third of the farm usage of electricity is accounted for in conjunction with the farm enterprises.

It is estimated that irrigation pumping accounted for 8 percent of the total kilowatt-hour used on Basin farms in 1952. Power requirement studies indicate that by 1962 the number of farms using electricity for irrigation pumping will increase fourfold, and the electric energy requirements for pump irrigation on farms will increase sixfold. This does not include the electricity required for pumping water into canals or reservoirs.

The demand for electricity in the Pacific Northwest poses a problem which will require revision of power requirement estimates and additional plant capacity as the situation develops more clearly. Substantial capital investment will be required for system improvements to increase plant capacity to meet future demands for power.

Rural Telephony

The percentage of farms having telephones is higher in the Columbia River Basin than in the United States as a whole. According to the 1950 Census of Agriculture, 54 percent of the farmers in the Columbia River Basin have telephones, while only 38 percent of all farms nation wide have telephones. The severe winters and adverse road conditions and the scattered settlement over much of the Basin makes telephone service a necessity. With the exception of a few sections of the Basin, telephone service can be made available to farms and other rural subscribers from existing telephone companies. Consequently, no sizable number of new telephone cooperatives or independent companies is likely to develop.

Credit

Development of a farm, a community, a reclamation project, or a river basin is to a large degree dependent upon, and influenced by, the amount and kinds of the credit available. If adequate credit is available, the development can proceed in an orderly, efficient manner which will be conducive to proper conservation and utilization of the natural resources. If credit is not available, development may be hampered even though other factors are favorable. Credit, properly extended, can serve as a catalyst in bringing about resource development and improvement.

Credit Now Outstanding

The magnitude of the agricultural credit needs of the Columbia River Basin are illustrated by the real estate and non-real estate debt of farmers in Oregon, Washington and Idaho.

On January 1, 1953 the farm real estate debt outstanding in the 3 states was slightly over 400 million dollars. Fifty-seven percent of this amount was represented by loans of individuals or other miscellaneous

lenders. The remainder was held by life insurance companies, 18 percent; cooperative Federal land bank system, 14 percent; commercial banks, 7 percent; and Federal lending agencies, 3 percent.

On January 1, 1953, the non-real estate debt of farmers reported by major institutional lenders within the three states totaled $170,000,000. Of this amount commercial banks held 66 percent; cooperative production credit associations and other financial institutions discounting with the Federal Intermediate Credit Bank held 23 percent, and the remaining 11 percent was represented by loans of Federal loaning agencies.

No data are available showing the amount of credit extended to owners of forest lands. Until 1953 national banking associations have been prevented from loaning on timberlands under the Federal Reserve Act. Public Law 285, 83d Congress, 1st Session, amends the act to permit loans up to 40 percent of the appraised value of the economically marketable timber on managed forest tracts offered as security. However, there are definite limitations to the amendment which make it only a partial answer to the credit problem. Loans will be for a period of 2 years only unless repaid in annual installments, in which case the loan period may be extended to 10 years.

Types of Credit Available

Private individuals account for a large proportion of the lenders in the farm mortgage field. Usually they are more liberal and less exacting than institutional lenders as to terms and purposes.

Commercial banks are of major importance in short-term credit fields. They also make available substantial amounts of credit when secured by real estate. Few restrictions are placed on the use of funds, once a credit rating is established.

Production credit associations make short-term loans for all types of agricultural purposes. These associations operate on a cooperative principle.

Life insurance companies and the Federal Land Bank system are the major institutional lenders to farmers seeking long-term loans secured by first mortgages on farm real estate. The Federal Land Bank is a cooperative.

Federal farm loans are available to farm families who are otherwise unable to secure satisfactory credit at repayment terms which would enable them to finance major adjustments in their farming operations. Long-term Federal loans are available for land purchase, farm and home building and small water facility developments. Short-term operating loans are also available for purchase of machinery, livestock, and other farm operating purposes.

Credit Problems

The credit needs for cropland areas have been reasonably well satisfied except for two major needs. Adequate long-term credit for farm development and improvement in new reclamation projects is often not available until a project has been in operation for a period of years. Some of the credit needs for installation of conservation practices or purchase of foundation livestock or major farm equipment have not been met due to short repayment periods on loans not secured by farm real estate. Many farmers use their real estate as a basis for credit needed to install conservation practices or acquire livestock and equipment.

Loans by commercial banking institutions to finance the manufacture of forest products and the purchase of merchantable timber for immediate harvest are common, but practically no loans are made

for the improvement and management of forest properties. In general, the period of amortization for loans secured by timber is so short that liquidation of the timber values is mandatory. The owner of forest land cannot borrow on the security of his timber and timberland alone at rates of interest and under terms of repayment adapted to a plan of forest management to build up growing stock and defer harvesting. Credit of the type currently available actually discourages good management in that no recognized value is given to immature timber. One of the major factors discouraging longer term loans on forest properties is the almost complete lack of disaster relief and insurance protection. It is very possible that adequate credit facilities will not be readily available until the timber used as security is protected by insurance. As with credit, such insurance must be at rates which will encourage the management of forests for sustained production.

Credit Needs

Development of the Columbia River Basin will create additional demand for credit to finance the various aspects of resource development. Credit programs in new development areas, involving irrigation, drainage or land clearing, should be designed so that the operator is assured of adequate amounts of credit for sufficiently long-term and at reasonable rate of interest to permit orderly development of the resources without the necessity of exploitive use in order to live. Modification of present lending policies may be required or additional Federal funds may need to be made available if private sources do not or cannot meet the farm credit needs.

Credit needs for development of the agricultural, range and forestry phases of the Columbia River Basin are complex. Basically, they

fall into 3 major categories: long-term credit for resource development such as reforestation, range improvement, and irrigation or drainage, and for farm purchase and farm buildings; intermediate-term credit for farm improvement, installation of conservation practices and purchase of foundation livestock or major farm equipment; and short-term credit for annual farm operation.

Maintenance and full economic use of the land resources are of basic concern to the community, state and nation. Credit should be of such types that long-term funds are available to permit proper types of resource improvement. The soundness of credit extension in forested areas will be dependent upon proper integration of protective measures (fire, insect, disease, and rodent) and equitable taxation with the credit extended. Federal and state credit regulations may require modification to permit private lending agencies to participate in extension of credit to resource development in the forest and rangeland areas.

The need for new sources of long-term, low-interest credit will be critical in areas where deteriorated sites and forest stands can, and should be, rehabilitated. Under present circumstances, loans are unattractive to present lending agencies.

The amount of total agricultural credit needed at any given time will depend on a number of complex, interrelated factors. For example, if the residents of the Columbia River Basin recognize the importance of establishing needed measures, the demand for money to invest in the capital improvements will create an accelerated demand for credit. If the economic situation of the nation is not prosperous, a greater percentage of the funds needed for developmental purposes may by necessity come from governmental agricultural lending agencies.

The social and political impact of the rapidly expanding population of the western part of the nation will have a marked effect on the demand for increased production of foods and fiber. This, in turn, will influence the rate with which the resources are developed and improved. Credit needs will therefore be intimately related to the rate and degree of development of the land and water resources.

The nation's foreign relations, whether there be peace or war, will have major influence on the credit needs of the Columbia Basin, both in timing and in amount.

The present and foreseeable economic level of the nation indicates that credit needs for farm development and improvement will be on a continually expanding basis. Costs of improvement have increased to such a degree that new or younger farmers must have increasing amounts of credit to become established or to make capital improvements in the farm plant.

Because of these complex factors no attempt has been made to predict the amount of credit needed for any one year or for total development of the Columbia Basin.

The benefits which will result from the proper types and adequate amounts of credit wisely extended are manifold. Farm, range and forest land owners will be enabled to develop and improve their resources in a sound manner without depletion. Income to land owners and operators will be increased. In addition, the processors and handlers of raw materials, manufacturers, transportation companies and wholesalers and retailers of consumer goods will benefit through increased business and from higher farm income. The counties, states and nation will also benefit from a more stable economy, and increased tax base, and increased profits of the producers, wholesalers and retailers.

Ultimate development of the agricultural resources of the Columbia Basin is dependent upon the active participation of farm and ranch families, timberland owners and operators; and upon the cooperation between farm, forestry, civic and commercial organizations; local, county and state institutions; and governmental agencies. Participation and cooperation can best be effected through complete understanding of the program, general agreement on the functions of all agencies, and the acceptance by both farm and forest people and governmental agencies of the responsibilities of each. This can be established best through educational means.

Educational Needs

General public understanding of the development proposals and appreciation of the possibilities for increased income and improved levels of living are necessary. Realization that adjustments in farming, range use, and forest land management can and should be made to maintain the lands and protect public investments in new dams, reservoirs, and other structures, and insure their full and efficient use over a long period of time is important.

Educational needs are of three types: to develop informed leadership and informed community organizations; to assist farmers, ranchers, and forest and woodland users to understand and adopt improved and new techniques, and to assist farm people to realize better living standards and farm efficiencies.

The anticipated scale of development in the program will make more acute the shortage of technically trained people to serve the various agencies and organizations that will be involved. Colleges, particularly in this area, should be aware of the unlimited opportunities such an important program affords properly trained graduates.

Educational Program

In order to contribute to meeting these and similar needs, the use of educational and service programs to be carried out with the cooperation and assistance of Federal, state and local agencies and organizations is essential.

The educational program is primarily designed to work with people on the land -- on private land. However, there is also need for considerable education in the proper appreciation, development and use of public lands.

Leadership and Community Organization

Definite plans must be made to inform interested or involved individuals as well as organizations with the program of development. The organized support of the public is essential to effect the ultimate program of the fullest and best interest to the Basin. This will involve not only rural people but in many instances urban as well. The future prosperity of the Basin's agriculture and forestry will greatly affect all other industry. Community development can only be achieved by the development of leadership and through adequate organizations.

New Techniques

In cropland areas, both irrigated and non-irrigated, rangeland, and forest land, education in proved methods and techniques and in latest research data must be made available.

The educational program is designed to meet the needs in three stages of area development, including planning and pre-construction, development and settlement, and the post development period.

The first stage will bring to the people information on the latest research and the experience of farmers concerning the adapt-

ability of the area, probable cost and benefits, and adjustments in farm and living situations, as well as probable market outlet. This will obviously be of great importance in new irrigation project areas and on farms changing to irrigation.

The second will supply more detailed information on soil-and-water-management problems, water requirements of major crops, market outlets for new products, and problems of farm management and home management under different farming situations.

Educational work in the third stage of development is particularly important in order that the whole community may fully utilize the opportunities for a balanced and more stable agriculture and better living.

Educational assistance on small or individual projects, as well as on large ones, is needed. These small projects, many of which are already established, involve many of the problems inherent in major projects and have some additional problems peculiar to small enterprises. These include poor distribution systems, incomplete land development, limited supply of water, inadequate maintenance, and the need for technical services in organization, finance, legal procedures, and engineering.

Farm and forest people should always be kept abreast of improvements in varieties, management, marketing, and all other forestry, farming, and homemaking practices. This should be a constant objective.

Forest Resources

Education of the forest land owners, both large and small, to properly manage and conserve the forests is of paramount importance.

The need for better cutting practices, more adequate protection from insects, diseases, and fire must be impressed upon the timberland owner, the operator, and his employees. Education in the management of forest lands and information as to available marketing channels are of primary importance. Croplands, rangelands and woodlands are often generally intermingled and constitute inseparable parts of a complex land use pattern. Integration of woodland management with other farm enterprises is a significant need. This is particularly true when we consider that a large percent of the private commercial timberland within the Basin is owned as part with adjacent or intermingled cropland or rangeland.

The use of the educational approach to encourage the rehabilitation of now unproductive or partly unproductive burned-over and cut-over lands, controlling fires, insects and disease, and changing from improper cutting practices will contribute to improve the situation. The public as well as the landowners must be made aware of the necessity for such a program.

Improving Levels of Living

The use of electric power in practically all rural communities has and is bringing new conveniences to farm families. Where electric power is just becoming available, particularly on new projects, families may need information on bringing water into the house, sewage disposal, electrifying the farmstead, telephones, and the selection and care of electrical equipment.

Increased industrialization will come about as new electric power is available. Expansion of industrial centers will provide more local market outlets for farm and forest products. Equally important is that industrial expansion provides an additional outlet

for employment of farm youth. Also the cost of developing and servicing improved health centers, recreational centers, and educational facilities will be shared by both rural and urban people.

Many families are receiving help in planning new houses, remodeling old ones, and reorganizing the farmstead. Home production of fruits, vegetables, and other food products provides a more adequate diet. Better health results.

Supporting Program

Of great importance is the job of supplying information concerning supporting programs of research and credit. The research program will continually make new information available. This will be disseminated through the educational program to farm and forest people and others interested as rapidly as available. Farm people will be assisted in applying research findings to their particular problems, as will owners of timberland. Educational work in relation to credit will familiarize farmers and ranchers with sound credit practices.

Educational Methods

Educational programs will be planned with rural people in their own particular areas and with representatives of agencies cooperating in the agricultural program. It is important that all available means be utilized to provide information and educational assistance to the rural groups to be reached as well as to the public as a whole.

Very effective educational work that is fundamental and of great potential benefit is that done with the children and younger people.

Wise use of conservation information in the seventh and eighth grades in grade schools, adapting Future Farmer training in the high schools to the development program, and the organization of 4-H clubs along these lines will greatly facilitate the Basin agricultural program.

Public Lands

The amount of publicly owned or managed land in the Basin actually exceeds that owned privately. Therefore, considerable education should be involved in understanding the problems and program for the vast area. Relatively few people understand the status of such lands with respect to ownership, responsibility, uses, and protective measures involved.

With the ever-increasing tourist travel in the Basin and accompanying recreational interests, greater appreciation of much of this land is resulting. This greater use is also bringing increased fire hazards to much of the timber and grasslands. Need for more and better roads is constantly increasing. The general public must be fully informed on the program for fullest economical development and use of this area in order that necessary Federal funds can be made available.

Personnel Requirements

There are now cooperatively employed with the Federal government land-grant colleges and the county governments in the Columbia River Basin some 405 men and women giving practically full-time to educational programs concerned with improving agriculture and homemaking practices. This staff is fully employed with current programs. The accelerated educational program here recommended will require about 220 additional county agricultural agents, 100 home agents and 50 specialists. These additional persons will be required gradually as the program develops over a period of years.

The first specialists employed should be in technical fields which will contribute most to the irrigation, drainage and erosion control features of the program. Such specialists would include agricultural engineers, soils specialists, and foresters.

Agricultural agents should first be added in counties where erosion is critical or in areas where new irrigation projects are being developed. They should be gradually added in other less critical areas where the present staff is unable to carry the accelerated load and where impacts of the various phases of the development affect the farm economy.

County home agents will be added first where new developments affect the living situation, particularly with respect to housing, use of electricity in the home, and where there are problems of living costs in relation to farm income during and following the developement period. The additional staff recommended will be supervised by the present supervisory staff and housed in present county offices where possible.

Research

The soundness and rate of progress of a business, a profession, a state, a nation is to a large degree dependent upon the adequacy and proficiency of research. Research encompasses all phases of the problems, physical, economic and social. Each phase of research, to be of practical value, is interdependent upon other phases of research. For example, basic research which is directed toward finding out "why" things occur is fundamental to applied research which is concerned with "how" things occur. Likewise, research findings on physical problems have more practical value when economic or marketing research finds methods of utilization of the products of physical research. Unfortunately, the pressure for solutions of problems which have an immediate pay-off has relegated the fundamental basic research to a position of lower priority in demands on available funds and personnel.

While the following sections are discussed by types of research or by land use, the whole research program is closely correlated and interdependent. The following kinds of research are considered essential to achievement of a sound land and water program for the Columbia River Basin.

Cropland Research

Among the many problems needing study in the irrigated sections of the Columbia River Basin are the irrigation water requirements of crops. These include the consumptive use of the crop as affected by climate; the effect of irrigation practices on water requirement; amount of water lost by evaporation from the land surface during and after an irrigation; the amount of precipitation that is effective in reducing irrigation requirements; canal and ditch losses and economical ways of decreasing such losses; practical methods of reducing deep percolation and surface runoff; and the effect of water cost on application methods.

On the steep rolling lands of the Basin, erosion by irrigation water is excessive. The effect of size of stream, slope, length of run, shape and spacing of furrows on different soils should be evaluated to develop recommended practices.

Serious drainage problems often develop when irrigation water is applied to the land. Instruments and investigational methods should be developed in order to secure data relating to soil and water relationships upon which effective drainage systems may be developed. At times, drainage may be practical only through the use of wells. In other cases, tile drains or open drains are best adapted. Criteria and limitations for the use of each method of drainage should be developed and made available to technicians who are responsible for assisting farmers.

On semiarid cropland, methods of control and disposal of runoff water which traverse croplands should be evaluated. The most effective

use of crop residues, terraces, diversion ditches, seeded water ways, strip crops, and crop sequence should be determined in the various soil types and rainfall areas. Information is needed on the effect of accumulation of snow and ice during periods of alternate freezing and thawing. Retardance characteristics of the grasses used in waterways should be studied.

Information is needed on amount of deviation from contours both as to percent of slope and length in strip cropping without sacrificing effectiveness. The width of strip for water and for wind erosion needs evaluation.

Some croplands west of the Cascade Range can economically use supplemental irrigation in order to insure improved quality and higher yields. Research on supplemental irrigation will be similar in many respects to that for the irrigated areas. Drainage on these lands may sometimes be needed more than in the irrigated sections of the Basin.

Research on physical properties of soils limiting or affecting plant growth should be expanded to solve many problems arising throughout the Basin. In the irrigated areas these problems include poor aeration and low infiltration rates or excessive infiltration rates and low water holding capacities. In the semiarid areas, permeability, erodibility, aeration and water holding capacity are of particular interest. On all soils, the effects of cropping systems, organic matter additions, type and weight of tillage equipment, soil amendments, stabilizers and drainage should be investigated with respect to these soil limitations. Considerable effort is warranted in developing equipment for rapid field determination of available water in the soils.

Principles and data on soil properties affecting their susceptibility to wind and water erosion are very meager. Basic research on principles will aid in solving these serious problems of land management.

The fertilizer requirements of soils require an expanded investigation program. Particularly, research should calibrate soil or plant tissue tests with field response data so that each field of each crop can more nearly attain the economic potential production. The effects of crop sequences in the rotation, the amount and kind of water used for irrigation, the effect of land leveling, etc., on fertilizer requirements should be more intensively studied.

Investigations on removal of toxic or excessive concentrations of salts, arsenic and boron and other materials by leaching, inversion of the soil, or counteraction by chemical amendments are essential.

Evaluation of a wide range of crops and varieties of crops for various climatic zones and soil conditions existing in the Basin with regard to yield, quality, hardiness, disease and insect resistance, erosion control and windbreak effect should be expanded. Such knowledges are needed particularly on new and potential reclamation projects where on-the-site information is invaluable to land development and conservation.

Programs in plant breeding, selection and introduction should be set up to broaden the choice of crops that can be grown and to produce desirable new varieties resistant to winter injury, frost damage, pests, lodging, and new strains of diseases. A wider range in maturities of processing crops is needed to extend the processing season.

Evaluation of the loss in crop yields and quality caused by insects and plant diseases, both as to known strains and new ones which

will inevitably arise, should continue at an accelerated pace both for more adequate prediction of need and guidance in use of control measures. Research on control of these crop hazards should be expanded to insure high production on the individual farm and in the Basin.

Control of the more troublesome and persistent weeds infesting much of the present crop land and quickly invading newly reclaimed lands should be much cheaper and surer if research is expanded on control by chemicals, cropping systems and cultural practices and combinations of these means.

In the field of crop management more information is needed on time and rate of planting and seed treatments in relation to yields, disease and insect control. Special problems of pollination, insect control and chemical defoliants to facilitate harvest of legume seed deserve increased attention.

Development of new and improved types of cultural and harvesting equipment is greatly needed.

Pastures are becoming increasingly important but many questions on kinds of grasses and legumes, their rates and dates of seeding, effects of fertilizers on yields and composition, carrying capacities and management to preserve longevity and desirable species composition for different classes of livestock should be further investigated.

Evaluation of a wide range of kinds and varieties of fruits and vegetables suitable for processing should be expanded.

Similarly a program of research should be conducted to evaluate the suitability for commercial processing of new kinds, strains and varieties of field crops such as alfalfa, dry beans and peas, wheat and other grain and forage crops.

Forest Research

The management of forest land for its many uses requires knowledge of the interrelations of trees, climate, and soil; of the characteristics of different tree species; of competition between trees and other plants; in total, of all the great variety of factors that affect, or are affected by forest establishment, tree growth, the harvesting of forest crops, and other forest uses. Research to provide a sound background for multiple use of forest land is underway, and though it has gone steadily ahead, there remains much to learn.

With respect to regeneration of forests after harvesting, research is needed to learn the abundance and periodicity of seed production, the time and distance of dissemination, the losses caused by natural enemies, how to choose the right numbers and kinds of seed trees, and methods of stimulating seed production on desirable trees. With regard to stand establishment, relative rates of growth, shade tolerance, competing vegetation, and physical and biotic injuries are factors which must be studied. It is necessary to learn how properties of the soil affect trees, how the trees modify them, and what forest practices such as thinning and logging do to the soil. It is also necessary that we understand the specific effects of rain, solar energy, wind, snow, freezing, relative humidity, and their effects on the natural distribution of trees.

There are significant possibilities of increasing forest productiveness by identifying or developing superior tree strains better able to resist parasites, grow faster, and in other ways excel run-of-the-woods trees. Research in improvement of trees by breeding will necessitate studies of: characteristics such as faster growth and how these are transmitted; how superior trees can be recognized, evaluated

and propagated; hybridizing, and field testing. A full-scale program of genetics research for the Columbia Basin should include development of improved seed procurement methods through the preparation of collection standards, and the registry of seed collection areas and of outstanding trees; critical evaluation of apparently superior stands and trees; studies in seed orchard technology, including methods of propagation; improvement of existing species; controlled pollination of trees outstanding in growth rate, form, wood quality, or resistance to damaging agents; and development of hybrids.

Tree physiology and the mechanics of growth processes need increased attention. Application of knowledge of a single tree or species can then be extended to the forest through silvicultural research. Silvicultural problems include the conversion of overmature timber stands into growing managed forests, restocking of burned and cutover lands now covered with unproductive brush, thinning young timber stands to reduce mortality and increase growth, and pruning to improve timber quality. Research is needed on all of these problems.

With changes in forest management and in forest products, utilization needs for improved measurements of forest trees have developed.

Refined methods of determining tree volumes and growth rates, and development of new volume tables for young-growth trees and for species becoming commercially important are increasingly needed.

Applied forest management research is needed to test in pilot commercial-scale operations on conclusions reached by small-scale studies. In most cases, cost records will be of prime importance. These studies would involve logging plans, logging methods, slash disposal, and water quality protection.

Research is needed in forest products utilization, to find new uses for secondary forest trees and to reach more complete utilization of the timber resource. This research would include development of uses for material now wasted, both in the forest and in the mill. It would also include reduction of losses from improper seasoning, insect attack, and rot.

Research in watershed management is needed to cover problems of water quantity and quality. It would involve basic studies of evapotranspiration losses, and watershed studies of the effects of the timber harvest and other operations on water supply. It would provide specifications for control of operations to safeguard water quality and to ensure favorable seasonal distribution of water yields.

Fire is a constant threat to the forest. Although fire control has become moderately effective, big fires are an ever-present possibility. Research is needed to develop improved fire prevention programs, to explore possibilities of preventing lightning fires through weather modification techniques, to develop better fire-fighting tools and methods. Research is needed to determine the effects of fire on soil and watershed values, and to find the best means of using fire as a tool in forest management.

Other phases of forest research dealing with soils, climate, pest and diseases, economics, and insurance and credit are dealt with in other sections of this report.

Rangeland Research

The management of rangeland for its multiple uses requires additional knowledge of the inter-relationships of the various factors which are fundamental to sustained high production.

To provide a base for improved range management, research of the ecology and physiology of range plants, both desirable and undesirable, is of utmost importance. Research findings will serve as guides in relation to proper rates of stocking, seasons of use, starting dates, kinds of livestock best adapted to various range conditions and locations. Ecological and physiological studies of important range plants need to be correlated with determinations of plant populations and trends under varying intensities of use; and of the behavior of the various range forage types in relation to different conditions of moisture supply, climate and soil.

Studies of the chemical and nutritive composition of the principal grazing species at their several stages of growth and grazing use are necessary to provide guides to proper season of use and stocking rates. Such research will also consider areas of adaption of native and introduced forage plants, tolerance of the various species and types to various intensities of use, and of forage preferences shown by different classes of domestic livestock, deer and elk.

Artificial revegetation is a recognized and useful method of rehabilitation of range land. Research is needed to determine what to plant, where to plant, when to plant and how to plant. These determinations are needed for each of the various climatic zones.

Range lands are one of the major catchment areas for precipitation. Research is needed to determine the effect of different degrees of range management, range condition, seasons of use and types of forage on the hydrologic behavior of the range lands. Hydrologic research will be needed to determine correlation between range condition and peak flow; total water yield, soil temperature, and density and composition of soil cover. Hydrologic research will include determination

of relationships of soil type, organic residues and vegetal composition to rates of infiltration, percolation, lateral ground water movement and evaporation. Studies of physical water control measures and of their relationship to water spreading, sustained streamflow, and irrigation of meadows are needed.

Range fires cause damages of millions of dollars annually. Research is needed to determine the rate of spread, amount of heat released by various range fuels, effect of climatic conditions, and effect of topography and elevation on the behavior of fires. Basic data on fires will be used for development of improved methods of control and for use of fire as a range management practice.

Research is needed to determine effects of degree, period and type of grazing on erosion. Studies should be made to determine the effect of soil stabilization practices, especially those that effect the management of the range, such as location, gradient and width of roads, erosion control structures, terracing and furrowing on the several grade slopes and location of watering places.

Much of the range land is used jointly by domestic livestock and big game. Research is needed to determine forage preference, seasonal use, grazing patterns and grazing capacity of ranges used jointly by livestock and big game. Studies are also needed to determine the effect of grazing practices and intensity of use by terrestrial and aquatic wildlife other than big game.

Other research pertaining to range, such as insects, rodents, and disease are discussed under the following sections.

Research Involving More Than One Type of Land

Heretofore, research needs have been discussed as applying primarily to one type of land use. However, certain resources, uses, and problems are not limited to one type of land. For example, a

large part of the Basin while producing crops, forage or timber, also produces water. The tendency has been to adhere to single-purpose management because of a lack of adequate guides to multi-purpose management. Comprehensive management requires information that must be furnished by research.

Needs in this field include studies of: the relative efficiency of different types of vegetation as watershed cover and in soil stabilization; the effects of logging and grazing on water yield and water quality; land use practices that will reduce soil disturbance to a safe minimum; of techniques and methods to improve the soil and rehabilitate areas where extensive site deterioration has occurred; method of torrent control; and plant species best suited to soil stabilization and erosion control.

Control of fire on forest and rangelands demands more knowledge of fuel types and fire behavior. Fire as a useful tool in certain phases of forest and range management needs to be thoroughly tested and evaluated.

The effects of land practices on game animals need to be determined and evaluated.

More detailed knowledge is needed of climatic factors and their effects and of the use of shelterbelts to protect crops and increase yields.

Investigation of the applicability and utility of cloud-seeding to modify water supplies must be continued.

Of concern to all phases of research is the method of collection and analysis of data. The patterns of scientific inquiry need constant refinement. Techniques applicable in one case must be changed to be used elsewhere. Continued study in the fields of sampling, measurement,

and analysis is necessary to improve research techniques and insure more adequate results.

Economic Research

The proposed land treatment and land use program will require farm and ranch operators to assume certain costs. To assist the operators in making decisions, research is needed in the economics of conservation to determine the effect of various practices on capital requirements, labor requirements, land use and returns.

Credit has not been readily available to either forest owners or settlers on new irrigation projects. In both cases, research is needed to determine credit requirements which will enable the operator to develop an economic unit and ways the credit needs can be satisfied. Research is also needed in established farming areas to determine the limits of efficient combinations of capital and labor and availability of credit to finance adjustments.

Closely allied with credit is the need for insurance to protect the forest owner from losses arising from major risks. Research is needed to develop a feasible insurance program for forest land.

The high capital requirements have made the acquisition of an efficient farm unit more difficult, and research is needed to analyze the problems involved in acquiring initial ownership of farm or ranch land, to analyze the problems associated with the acquisition of additional land, and to evaluate economically the tenure process. For rangelands, research is needed to determine the relationship of size, pattern, and type of ownership to intensity and kind of management. Also, for range there is need for research to analyze the effects of various land costs on range management. For forest lands, research

is needed in tenure to determine the pattern of land ownership and the manner in which owners exercise and control their ownership rights.

Land managers are constantly faced with meeting many uncertainties, and research is needed which will enable the operator to adjust his operations to the uncertainties arising from disease, pests, weather and other physical factors, from technological advancements, from changes in price relationships and from changes in the foreign situation.

No matter whether a manager operates crop, range, or forest land or a combination of these, he is concerned with attaining an economic unit. To assist him, research is needed to determine the best combinations of factors of production. In case of a farm, research is also needed to determine the best combinations of enterprises.

The development of irrigated land has become increasingly costly, and considerable economic research work is needed to guide sound development. Research is needed to determine what lands are physically and economically feasible for irrigation, to analyze the economics of sprinkler irrigation and to appraise the rate of settlement progress.

In farming areas characterized by long rainfall cycles, research is needed to determine the economic limits of a farming economy based entirely on range, entirely on wheat, or on a combination of the two, and to determine the extent to which land use does or should change.

The agricultural economy is dependent upon an efficient marketing system which assembles, processes and moves agricultural products to areas of consumption. Research is needed to determine the flow of agricultural products, and to assist in the development of efficient marketing channels. For forestry, this would require a study of the

entire distribution system of forest products and an analysis of how the different segments of the system are related.

The increase in population has a significant effect on the use of land. Research is needed to determine the relationship between intensity of land use and size of operating unit, tenure, type of use, land values, and other similar factors and to determine how these shifts in intensity of use can be accomplished with the least interruption.

The competition between big game and livestock and between kinds of livestock for the use of range resources is particularly acute in some areas. Research is needed to determine the relative benefits derived from big game and livestock production and ways to obtain desirable adjustments in areas where big game and livestock compete for the available forage. In areas where there is a lack of balance in seasonal range use, research is needed to determine the effect of this lack of balance on the use of the range.

Research is needed to appraise new methods, new equipment, new practices and other technological innovations to determine the effects of the adoption of these innovations and to determine the actual benefit.

Fluctuations in the economic cycle affect the conservation and development of our basic resources. Research is needed to determine how variations in the economic cycle influence the nature, extent, and timing of the conservation, development and use of our basic resources.

Full use of research findings require that there be a knowledge of the economic development which is likely to take place in the near future, and research is needed to determine the extent of growth and development in the Columbia River Basin, to analyze the flow of money

and to classify economic activities. Research is also needed to analyze changes in population consumption habits.

Many indirect benefits accrue to the economy because of the development and improvement of our basic resources. Research is needed to appraise these indirect benefits and the effect of these benefits on the cultural growth.

The role of Federal, state, and local governments in the conservation, development, and utilization of our resources has increased. Research is needed to determine the effects of government policies on income stability, distribution of income in agriculture, and distribution of income between agriculture and the other segments of the economy and to determine the effects of governmental policies on resource development and utilization.

Weed, Pest, and Disease Research

Weed control is important to agriculture. Weeds cause reductions in crop yields. Weed seeds contaminate harvested crops. Poisonous plants cause losses of livestock as well as reducing the growth of good forage. Control of the more troublesome and persistent weeds infesting many cropland and rangeland areas could be made cheaper and surer by means of research to improve present control methods. Such plants as quackgrass, Klamath weed, bindweed, whitetop and Canadian thistle warrant special attention on croplands, and the poisonous halogeton and larkspur on rangelands. Surveys to determine extent and density of weed infestations, and evaluation of control and eradication measures represent a continuing need. As agricultural development increases, weed problems become intensified; research is needed to find effective specific herbicides and to develop systems of control through tillage and other cultural practices.

Allied to the weed problem is that of the unpalatable sagebrush and rabbitbrush which crowds out good forage plants on rangeland, and that of the brushfields which have invaded burned and cut-over forest lands. As with the herbaceous weeds, research is needed on the life histories and ecology of these plants as a basis for intelligent application of control measures as well as on agents and cultural practices for control.

Insect pests attack growing crops and stored farm products, range forage plants, forest trees, and livestock, causing tremendous losses. Insects destroy more timber each year than the lumbermen cut. The first control step is prevention; it is dependent upon knowledge of factors that cause sudden and widespread epidemic build-ups. Regular surveys are needed to measure extent of insect infestations and to detect incipient outbreaks. Research is needed to discover and test possible indicators of insect outbreaks, to furnish additional information on the habits and environments of various insect species, and to develop and test insect-control materials and techniques. Attention must be given to forest enemies such as the Engelmann spruce beetle, the Douglas-fir beetle, the western pine beetle, the spruce budworm, and the western hemlock looper. Also in need of immediate attention are such range pests as grasshoppers, crickets, tent caterpillars, and the Pacific grass bug; and such cropland pests as nematodes, clover seed beetles, pea aphids, the granary weevil, the rice weevil, and the lesser grain borer. Increased impoundment and distribution of water will likely create additional public health problems such as those involving mosquitoes. While these problems are outside the scope of this report, they are recognized. Research will be needed to assist in their solution.

Rodent pests cause damage of various kinds, and are responsible for heavy losses. While adequate control programs have been developed for some species, considerable research is needed on methods of control of rodent populations, on the life histories and environments, and on determining extent and significance of rodent damage. Attention needs to be given to developing effective and economic means of reducing timber damage by porcupines and seed destruction by chipmunks and mice in forest areas, mouse and gopher and ground squirrel damage to range forage, and rat and mouse damage to stored farm products.

Research is needed on numerous plant diseases that provide serious threats to agriculture and forestry. Important diseases, about which more needs to be known and for which adequate controls must be developed, include potato scab, verticillium wilt, several smuts and rusts and root rots on croplands and rangelands, the pole blight and blister rust of white pine and various root rots on forest lands. Losses to plant diseases must be evaluated, new diseases must be identified, soil fumigants and sterilants must be developed and tested, and means of controlling disease through cultural practices must be worked out. Relationships of present use and management practices to plant diseases need to be determined. No positive control programs can be undertaken until research has shown the way.

Surveys

An accurate inventory of the resources of the Basin is basic to proper planning for and utilization of these resources. The following types of surveys are deemed of primary importance in sound, progressive development.

Soil and Erosion Surveys

A thorough knowledge of the soils - their nature, distribution, location, behavior, suitability for use, management requirements, and productivity - is required to attain a high level of use, development, and conservation of the land and water resources of the Basin.

Soil surveys are designed to determine the characteristics of soils, to classify soils into defined series, types, and other units, to establish and plot on maps the boundaries among kinds of soils, and to predict the suitability of soils to various crops, grasses, trees, or other uses, their behavior under different use and management systems, and the yields of adapted plants under specified management practices.

Soil surveys are used in many ways, but perhaps their most fundamental purpose is to secure information upon which to make sound predictions about soils and their behavior, which can be applied in agriculture, including forestry and grazing, and certain engineering problems. Soil surveys are a necessary part of an effective soil research and advisory program. Besides serving as a geographic frame of reference in the planning of field, forest, and laboratory research, soil maps and reports serve as a basis for classifying, synthesizing, and reporting the results of research and experience on soils and their behavior and the extension of this information to other areas.

Requirements for detail on surveys will depend on the type and intensity of land management, the land use pattern, the kind and number of varied uses to be made of the survey. The major kinds of land use in order of decreasing intensity needs, together with acreages needing detailed soil surveys, are as follows: irrigated lands and new irrigated projects, 5,898,000 acres; non-irrigated cropland areas,

6,774,000 acres; forest areas, 23,745,000 acres; non-forested range, 55,177,000 acres, and other land, 6,632,000 acres. The acreage for which detailed soil surveys are needed totals 108,226,000 acres.

Erosion surveys can be made an integral part of the soil survey. Information needed includes the kind, location and hazard degree of soil erosion over large areas. Such a survey will furnish information on the present rate of erosion, the susceptibility of various soils to erosion and the effects of erosion on various soils and slopes. Erosion information, in addition to that ordinarily obtained in past detailed soil surveys, is needed on the following: stream bank erosion and sheet, gully and wind erosion.

Water Supply Surveys

Data on peak and seasonal flows of small streams, those ranging from less than a square mile to about 20 square miles in size of drainage area, are particularly needed in agricultural areas throughout the Basin for the design of flood control, drainage, and irrigation works. Peak flow data are needed for the design of such structures as gully control dams, culverts, channels, diversions and outlets.

These same data are needed by Forest Service and State and County highway engineers for the design of culverts and small bridges. Data on seasonal flow on small streams are needed for the design of drainage systems and irrigation storage reservoirs and systems. It is estimated that a total of 2,225 crest stream gages and 525 recording stream gaging stations are needed on small streams. The work of agencies collecting streamflow and other hydrometeorological data needs to be greatly increased.

Snow surveys form the basis for predicting seasonal stream flow. Surveys of about 170 new snow courses are needed. Surveys on present courses should be intensified.

Water storage surveys include ground water surveys and observations, reconnaissance surveys and inventories of potential reservoir sites on small streams. Underground storage basins will be drawn on for irrigation, municipal, industrial, and domestic water, as the area is developed. As soon as ground water use is developed, ground water observations should be started to determine safe water yield and to prevent economic hardship caused by over-development and water depletion.

Relatively few surveys have been made of potential sites for small reservoirs on small streams and exploration and development of ground water reservoirs. Reconnaissance surveys are needed on 58,000 square miles of the Basin. Detailed studies should be made as development proceeds and the need for more detailed information arises.

Almost every year at several points in the Columbia River Basin, extraordinary floods occur. Flood damage surveys are needed to obtain information on agricultural and land damages of floods when they occur. This sort of information is necessary in the formulation of policies and programs of assistance to farmers in such areas.

Climatic Surveys

Precipitation, temperature, and other climatic data are especially lacking in unsettled areas and at the higher altitudes in parts of the Basin. Sampling is inadequate, and often misleading, where extreme differences are caused by marked topographic or other disturbances. More evaporation data are needed at well-chosen stations.

Additional climatic observation stations are needed in the Basin to improve coverage in the hydrometeorological network, improve flood warning services, improve operation of dams for flood control, irrigation, or power development, determine frost-hazard areas, and to improve management practices. The number and types of climatic stations needed to supply this information are as follows: 360 standard and 190 recording precipitation stations, 245 temperature stations and 10 evaporation stations.

Other Basic Surveys, Including Cadastral

In order to adequately manage the land and related resources and to carry out expeditiously a program as outlined, landowners and operators must have at their disposal accurate, up-to-date basic survey data and maps. Included in this item are basic aerial surveys and maps, General Land Office surveys and maps, land line surveys, general area surveys, and related cadastral surveys.

The greatest need for this type of information is in the remote, relatively undeveloped portions of the Basin. Consequently much of the needed work is on lands in public ownership. More than one type of survey and map will be required for many specific areas. In the aggregate a total of 234,000 square miles of survey and map work are required.

Forest Resource Inventory

This project is designed to obtain information for, and keeping current at specified standards, a comprehensive survey of forest resources of the Columbia Basin. The subject matter includes an inventory of timber resources by species, type, stand-size class, and ownership, in terms of volume and area; annual growth and annual drain by species group, broad ownership class, and stand-size class; annual

mortality by cause, species group, and stand-size class; and pertinent related information on use and need of forest products by major segments of the forest products industry. Forest site information and growth data will be obtained with a sufficient degree of refinement to compute the potential timber volume and yield under various conditions of management, and existing or proposed forest land programs. Interpretation and analysis of the data will be made for critical local areas. Resurveys will be made in the field at from 10 to 15 year intervals.

This information is widely used by all levels of government as background for policy decisions on legislation in the field of forestry. It is used, and needed, by forest landowners and forest land managers, and by local community organizations such as chambers of commerce, in appraising the forest situation of their locality and in deciding on long-term actions they should take to better their particular interests.

Range Resource Inventory

This project is designed to obtain information for, and keeping current at specified standards, a comprehensive survey of the range resources of the Columbia Basin. Subject matter includes an inventory of range resource by species, type, ownership, condition and density in terms of grazing capacities and areas; range condition trends by species, types and broad ownership classes; range use by types, location and ownership groups; and pertinent related information on use and need of range resource by domestic stock and game animals. Range site information and similar data will be obtained to compute potential use and grazing capacities under various conditions of management, and existing or proposed rangeland programs. Interpretation and

analysis of the data will be made for critical local areas. Resurveys will be made in the field at about 10-year intervals.

This information is needed by all levels of government as background for policy decisions. It is needed and would be used by rangeland owners and managers, and by local community organizations, in appraising the range situation in their localities and in deciding on long-term actions which should be taken to improve their particular interests.